

Organization and Structure of National Agricultural Research Systems in Anglophone sub-Saharan Africa

by

T. Ajibola Taylor



International Service for National Agricultural Research

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January 1991



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ACKNOWLEDGMENTS

The author wishes to express his thanks to the Chairman and members of the ISNAR Working Group on Organization and Structure. Many members made useful comments and suggestions. Jacobine Verhage provided valuable assistance in the design and preparation of the figures.

This paper is part of a project on the organization and structure of national agricultural research systems, supported in part by special project funding from the Canadian International Development Agency (CIDA).

Citation:_____

Taylor, T.A. 1990. Organization and Structure of National Agricultural Research Systems in Anglophone Sub-Saharan Africa. Working Paper No. 38. The Hague: International Service for National Agricultural Research.

AGROVOC Descriptors:_____

Research; Organization of research; Public research; Management; Research institutions; Africa.

CABI Descriptors:_____

Agricultural research; Management; Organization of research; Research institutes; Government research; Africa.

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ACRONYMS

ABU	Ahmadu Bello University, Nigeria
ADA	Agricultural Development Agency, Zimbabwe
ADC	Agricultural Development Corporation, Kenya
ARC	Agricultural Research Council, Zimbabwe
ARCN	Agricultural Research Council of Nigeria
ARI	Agricultural Research Institute, Ethiopia
ARRI	Aquatic Resources Research Institute, Ghana
ASARC	Agricultural Sciences Advisory Research Committee, Kenya
AgDP	Agricultural Domestic Product
CIAT	Centro Internacional de Agricultura Tropical, Cali, Colombia
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico
CIP	Centro Internacional de la Papa, Lima, Peru
CRI	Crops Research Institute, Ghana
CRIG	Cocoa Research Institute of, (Ghana)
CSIR	Council for Scientific and Industrial Research, Ghana
DR&SS	Department of Research and Specialist Services (Zimbabwe)
EEAFRO	East African Agricultural and Forestry Research Organization, Kenya
EATRO	East African Trypanosomiasis Research Organization, Uganda
EAVIRO	East African Virus Research Organization, Uganda
EAVRO	East African Veterinary Research Organization, Kenya
ECF	East Coast Fever
ECGA	Empire Cotton Growing Association
FAO	Food and Agriculture Organization of the United Nations
FMST	Federal Ministry of Science and Technology, Nigeria
FPRI	Forest Products Research Institute, Ghana
FRI	Forestry Research Institute, Nigeria
GDP	Gross Domestic Product
GNP	Gross National Product
IAR	Institute of Agricultural Research, Nigeria
IAR&T	Institute of Agricultural Research and Training, Nigeria
IBPGR	International Board for Plant Genetic Resources, Rome
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India
IITA	International Institute of Tropical Agriculture, Ibadan, Nigeria
ILCA	International Livestock Center for Africa, Addis Ababa, Ethiopia
ILRAD	International Laboratory for Research on Animal Diseases, Nairobi, Kenya
IRRI	International Rice Research Institute, Philippines
ISNAR	International Service for National Agricultural Research, Netherlands
KARI	Kenya Agricultural Research Institute, Kenya
LAC	Lesotho Agricultural College, Maseru, Lesotho
MUARIK	Makerere University Agricultural Research Institute Kabanyolo, Uganda
NARB	National Agricultural Research Board, Uganda
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NCST	National Council of Science and Technology

NITER	Nigerian Institute for Trypanosomiasis Research, Kaduna, Nigeria
NRC	National Research Center
NUL	National University of Lesotho, Roma, Lesotho
PPS	Physical Plant Services
RRC	Regional Research Center
RRI	Rubber Research Institute, Nigeria
SRI	Soils Research Institute, Ghana
SUA	Sokoine University of Agriculture, Tanzania
TALIRO	Tanzania Livestock Research Organization, Tanzania
TARO	Tanzania Agricultural Research Organization, Tanzania
TPRI	Tropical Pesticides Research Institute, Tanzania
UAC	Uyole Agricultural Center, Tanzania
UTRO	Uganda Trypanosomiasis Research Organization, Tororo, Uganda
WACRI	West African Cocoa Research Institute, Ghana
WAIFOR	West African Institute for Oilpalm Research, Nigeria
WAITR	West African Institute of Trypanosomiasis Research, Nigeria
WAMRRU	West African Maize Rust Research Unit, Nigeria
WANA	West Asia and North Africa
WARDA	West Africa Rice Development Association, Bouake, Côte d'Ivoire
WARRI	West African Rice Research Institute, Sierra Leone
WATBRU	West African Timber Borer Research Unit, Ghana
WSPRU	West African Stored Products Research Unit, Nigeria
WSTDA	National Science and Technology Development Agency, Nigeria
ZRTC	Zonal Research and Training Center

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**ORGANIZATION AND STRUCTURE OF
NATIONAL AGRICULTURAL RESEARCH SYSTEMS
IN ANGLOPHONE SUB-SAHARAN AFRICA**

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1. Introduction

The origins of agricultural research in both anglophone and francophone developing Africa date back to the colonial era of the 19th century. The national research systems presently in place have organization, structure and management cultures which are partly a heritage of the colonial past blended with some modern orientation, exposure to other systems and, in some cases, reform, following independence in the 1960s. In anglophone Africa it can be said that only a few of the research systems are fully designed or have been redesigned deliberately to meet the needs and challenges of post-independence development. This is in contrast to the varied forms of "nationalization" in francophone countries that took place only 10-15 years after independence. In anglophone countries most systems have evolved with gradual changes and learning by trial and error. Institutional evolution has continued as these countries face the challenges of rapid agricultural growth to meet their population, economic and industrial needs and welfare. But the challenges and pressures, as well as developments in the contemporary world, dictate that these systems consciously evolve, develop and strengthen themselves to become more effective and efficient in contributing to the acceleration of agricultural growth and development. These seem to be the priorities of the governments and agencies that fund agricultural research and of the clients of research.

Structure and organization is only a part of the research system, perhaps even just a framework, within which the research process of diagnosing problems; assessing world knowledge sources of improved technologies; mobilizing physical, human, financial and information resources to conduct research; testing and communicating findings and conclusions, take place. All these elements are important in the essential service that agricultural research must perform for the agricultural industry.

The purpose of this overview paper is to review the organization and structure of NARS in anglophone sub-Saharan Africa, to identify the causes and course of their evolution, assess their strengths and weaknesses, and indicate areas in which their strengths can be developed or reformed to make them true pillars of the development process in the agriculture of Africa in the decade to 2000 AD and beyond. For this purpose it will be necessary to classify, categorize, compare and draw lessons from these systems, and to point to arrangements that might help other systems in the design or redesign of systems for the future.

2. Background

Anglophone sub-Saharan Africa spreads from Sudan in north/central Africa to southern Africa, from Gambia in the west to Somalia in the east, and from Namibia and Lesotho in the south, and includes large and small countries which, as a result of their colonial history, have developed structures and organizations of agricultural research that have common trends and draw heavily on the British experience. Of the 44 countries in this region of Africa, 18 are Anglophone and share this common heritage and orientation.

These countries fall into three broad sub-regions as follows:

West Africa: The Gambia, Ghana, Liberia, Nigeria, Sierra Leone

Central and Eastern Africa: Kenya, Somalia, Tanzania, Uganda, Sudan

Southern Africa: Botswana, Malawi, Namibia, Lesotho, Swaziland, Zambia, Zimbabwe

Populations vary from 0.78 million in The Gambia, to 1.1 million in Botswana and 1.62 million in Lesotho, to 100.6 million in Nigeria, with several countries in the range 0.7 - 46 million. These populations are growing at annual rates of 2 to 4%, and they will more than double in the next 25 years. For example, the population of Zimbabwe is expected to reach 11.9 million, Uganda 22 million, Kenya 36 million and Nigeria 139 million by the year 2000.

The GNP for these countries also varies from US\$ 170 million for The Gambia, US\$ 730 million for Lesotho, to US\$ 75.9 billion for Nigeria. The per capita GNP vary from a low of US\$ 110 for Ethiopia, US\$ 170 for Malawi, US\$ 790 for Nigeria and US\$ 830 for Lesotho to US\$ 870 for Namibia, with ranges of US\$ 230 for Uganda and US\$ 740 for Swaziland in between. Contributions of agriculture to the GDP (AgDP) vary from 7% in Namibia to 41% in Ghana, 44% in Ethiopia, 49% in Tanzania, 52% in Somalia and over 60% in Uganda. Distortions are common, as in Nigeria where agriculture now contributes only 25% of the GDP as compared to over 60% in the early '50s and early '60s, because of the oil industry; and Namibia where prosperous mining depresses agricultural contribution to the GDP to a mere 7%. The growth rate in agricultural production in West, Central and East Africa are expected to be about 2% and slightly above 2% in southern Africa in the period between now and 2010 AD, with growth rate for cereals varying from 2 to 4%, root and tubers 2.5 to 3.5%, and total crops and livestock from 0.5 to nearly 6% for in the same period (FAO, 1986).

There is in all countries a great drive for improved food security, greater self-reliance, and the application of improved technology for increased production and productivity of agriculture.

The major food crops include cereals, such as maize, sorghum, wheat, millet; roots and tubers, such as cassava, sweet and white potatoes, yams; livestock products based on cattle, sheep and goats, poultry and pigs mainly; and a whole range of horticultural crops, green vegetables and oil-producing crops.

Table 1: Regional Profile of Anglophone Sub-Saharan African Countries

Country	Total Population (million)	Agric. Population (1000s)	Arable Land (000 ha)	GNP (mil (US\$)	GNP p/cap. (US\$)	Percentage AGDP (US\$)
Botswana	1.1	798	1360	900	830	6
Ethiopia	45.9	35830	13880	4630	110	44
Gambia (The)	0.8	559	156	170	230	27
Ghana	13.5	7717	2760	4960	390	41
Kenya	22.0	18183	2275	5960	290	27
Lesotho	1.6	1331	292	730	470	17
Liberia	2.4	1712	371	1040	470	17
Malawi	7.5	5894	2320	1160	170	36
Nigeria	100.6	69200	30385	75940	790	25
Namibia	1.2	620	657	990	870	7
Sierra Leone	3.8	2434	1766	1380	380	33
Somalia	6.2	3531	1066	1450	250	52
**Sudan	25.6	14673	12417	6920	360	
Tanzania	23.2	20180	5160	5840	270	49
Swaziland	0.7	485	189	490	740	25
Uganda	15.5	14075	5680	3290	230	60
Zambia	7.1	5145	5108	2620	390	16
Zimbabwe	8.6	6758	2539	5450	670	14

* Sources: ISNAR Data base
Encyclopedia Britannica 1987

** Sudan NARS is reviewed under WANA

Table 1 summarizes the regional profile for these countries of sub-Saharan Africa.

3. Historical Perspectives

The origin of agricultural research in anglophone sub-Saharan Africa is almost invariably associated with the introduction of new crops or commodities and the stimulation of the production of raw materials such as cotton, cocoa, tea and coffee linked with industrial development and client demands in the metropolitan countries.

The specific developments were associated with the establishment of botanical gardens where these new crops were studied, evaluated and from which distribution, dissemination and production were promoted. These approaches stimulated economic activities and the foreign exchange earning capacities of the countries concerned, but there was no real concern for the specific objective of balanced and efficient development of the natural resource base or, until much later, concern for food or improved nutrition of the peoples.

With the increasing and burgeoning population problems, agricultural research in the late '50s, early '60s and the '70s began to address both cash and food crop balance (quantity and quality) problems more rigorously in order to support the population and provide reasonable and improving standards of living.

The specific challenges were provided, among other things, by:

- increasing population and land pressure;
- outbreaks of pests and diseases;
- independence and attempts to redefine development strategy and needs;
- the need to stimulate agricultural growth as a base for industrial and technological development and advancement.

These challenges influenced and continue to influence the trends of organization and structure of agricultural research in the latter half of this century. The national agricultural resources for these countries, expressed as 1980-85 averages, are presented in Table 2.

4. Institutional Framework and Development

4.1 The early years

NARS in developing countries of sub-Saharan Africa comprise all institutions carrying out agricultural research in the public, private, governmental, non-governmental, university, parastatal and other agencies. In some cases these institutions combine research with development, extension and service activities to the agricultural industry.

In anglophone sub-Saharan Africa, these institutions have ranged from multipurpose departments of agriculture which carried out:

- plant introduction and testing (botanical gardens);
- agronomic research for crop production (including breeding, selection and improvement of specific commodities such as cotton, coffee, cocoa, tea, sisal, oil palm);
- soils research (management, improvement and fertilizer use and management);
- plant protection related to major cash or export crops (cotton, cocoa, coffee, etc.) and latterly to food crops;

Table 2: National Agricultural Research Resources (1980-85 average)

COUNTRY	(1) Number of Scientists	(2) Research Expenditure	(3) Research Exp. per Scientist	(4) Ag. Research Intensity Ratio
BOTSWANA	53	5.849	114	4.41
EGYPT	4246	36.522	10	0.44
ETHIOPIA	126	11.323	94	0.21
GAMBIA	62			
GHANA	138	3.344	26	0.11
KENYA	462	28.397	68	0.86
LESOTHO	18	6.043	336	3.90
LIBERIA	33	5.247	167	2.83
MALAWI	80	4.902	60	0.55
NIGERIA	1005	92.393	92	0.60
SIERRA LEONE	46	0.946	15	0.42
SOMALIA	26	0.322	9	0.06
SUDAN	193	13.683	75	0.33
SWAZILAND	11	2.472	349	1.68
TANZANIA	276	20.417	54	0.62
UGANDA	185			
ZAMBIA	104	3.576	38	0.68
ZIMBABWE	153	17.448	116	1.86

SOURCES:

- 1) Personnel and Agricultural Research Expenditures: Pardey, P.G., and J. Roseboom. "Agricultural Research Indicator Series: A global database on national agricultural research systems". International Service for National Agricultural Research, The Hague (unpublished draft version, 1988)
- 2.) Agricultural Gross Domestic Product (AgGDP): UN. "Gross Domestic Product by Board Economic Sector." Office for Development Research and Policy Analysis of the United Nations Secretariat, New York, 1988. Mimeo.

DEFINITIONS:

- (1) Scientific personnel with at least a B.Sc. degree (or equivalent)
- (2) Agricultural research expenditures (in millions of 1980 US\$)
Agricultural research expenditures were first deflated into constant 1980 local currency units using an implicit GDP deflator (UN, 1988) and then converted into 1980 US\$ using PPP over GDP indices from Summers & Heston (1988).
- (3) Agricultural research expenditures per scientist = agricultural research expenditures/number of scientists (in 1000's 1980 US\$)
- (4) ARI (Agricultural Research Intensity Ratio) = agricultural research expenditures/AgGDP (in percent)

NB: All observations are five-year averages. Column 3 does not necessarily match with columns 1 and 2 because in a particular year either a personnel or an expenditure figure may have been missing.

- animal introduction, breeding, nutrition and improvement; e.g., cattle, pigs, poultry, and small ruminants;

to departments of agricultural research which concentrated on agricultural research and development linked with extension in a ministry of agriculture.

A second development in the agricultural research framework was the advent of the agricultural development corporations (ADCs) or agencies (ADAs) which required information and technologies to increase the effectiveness and productivity of specific lead crops and commodities. This led to the creation of more stations and the expansion of research activities, but there was no pursuit of a distinct strategy and plan or wholesale reform of the evolving research system or its institutional framework.

This period I refer to as the period of growth by "accretion" - that is the increase in activities based on the "crystal" of previous activities as a response to new challenges of population and economic growth, and aspirations of the peoples to improved social and economic welfare. This situation has been largely characteristic of agricultural research systems in western, eastern and southern Africa.

4.2 Inter-territorial and regional research

The era of the inter-territorial and regional research organization of the '50s to the '70s had a major influence on agricultural research and the development of national research systems in a most profound way. These organizations were developed in western, eastern and southern Africa at different times, but they adopted essentially similar rationale and attempted to focus on regional problems of research and development with a long-term time frame and regionally sustainable approaches.

In anglophone West Africa (Nigeria, Ghana, Sierra Leone and The Gambia) such organizations were evolved as follows:

- West African Institute for Trypanosomiasis Research, Nigeria (WAITR);
- West African Cocoa Research Institute, Ghana (WACRI);
- West African Institute for Oil Palm Research, Nigeria (WAIFOR);
- West African Maize Rust Research Unit, Nigeria (WAMRRU);
- West African Stored Products Research Unit, Sierra Leone (WASPRU);
- West African Timber Borer Research Unit, Ghana (WATBRU);
- West African Rice Research Institute, Sierra Leone (WARRI).

While each of these organizations was headquartered in one of the countries, it focused its research on the identified common problems in the region and operated a network of substations in the other countries as considered appropriate. This assured useful exchange of information and the recognition of all the countries in the complex as clients of research.

In eastern Africa, the East African High Commission developed the East African Community research institutions with mandates for commodities, systems and studies that cut across the English-speaking eastern African countries as follows:

- East African Agricultural and Forestry Organization, Kenya (EAAARO);
- East African Freshwater Fisheries Research Organizations, Uganda (EAFRO);

- East African Veterinary Research Organization, Kenya (EAVRO);
- East African Trypanosomiasis Research Organization, Uganda (EATRO);
- East African Virus Research Organization, Uganda (EAVIRO);
- Tropical Pesticides Research Institute, Tanzania (TPRI);
- Empire Cotton Growing Association, Uganda (ECGA).

In Southern Africa, the Central African Research Organization with units in the former Rhodesia (Zambia and Zimbabwe) and former Nyasaland (Malawi) was similarly developed to address problems common to the agriculture and natural resource utilization and management of these countries. In general, these organizations were more natural resource conscious, well-managed, highly successful, and oriented to sustainable agricultural development and management, although not necessarily at the pace required by the nationals. They were successful in the transfer of useful information and conclusions among countries and in the efficient use of the resources for agricultural research made available through the Treasuries of the respective countries.

The break-up of these organizations in the 60s in West Africa and the mid-70s in Eastern Africa and Southern Africa marked the end of effective collaborative research in transnational organizations and structures that undertook the research process in a meaningful and probably cost-effective manner. It also marked the beginning of the development of national agricultural research systems (NARS) as we know them today, having evolved in a variety of ways in the 70s and the 80s.

4.3 The national research systems

Most of the national research systems that developed in anglophone sub-Saharan Africa in the latter period were merely conversions of government departments of agricultural research and inter-territorial research organizations. This sometimes happened with minimal changes in mandate, and the addition of other institutions considered strategic, appropriate or desired, in the context of development for the independent status of the nations concerned. There was hardly any marked or significant change in stated objectives, strategies or even approaches. There was more of the maintenance of research tradition and the concern for scientific excellence, not necessarily relevance, in research.

Although some lip-service was paid to serving the national interest, programs and projects were more in line with the interests of scientists, and in fact the standards upheld and sustained were more those of scientific excellence and international acceptance that were set in the colonial period, and few or minor changes were made in organization and structure. For example, such institutions as the TPRI (Tanzania), UTRC (Uganda), NITER (Nigeria), although now national, more or less retained their status and mandates without serious reviews or reorientation. In a recent development in Tanzania proposals are under consideration to review and revise the research station network, based on the agro-ecozones of the north and south coastlands, the north arid lands and Masai steppe, the central and southeastern semi-arid lands, the subtropical and semi-temperate highlands, the alluvial plains, and the western and southern plateaux. The review of TPRI in relation to its mandate and national responsibilities would now be part of this exercise.

The decline in the financing and sustenance of many institutions led to the decline in research-based productivity or management in some of these countries and created the bases in many cases of weak

NARS in anglophone sub-Saharan Africa. The leading position of Nigeria in oil palm research in the '50s and the '60s, for example, changed from that of a major exporter of palm produce to a major importer of oil-palm-based vegetable oils in the '70s and the '80s. Cocoa research also declined in West Africa but managed to pick up in the '80s. In eastern Africa greater success was achieved for coffee and tea, mainly because research on these commodities was organized outside the national public service system. In southern Africa great success was achieved with tobacco and tea in Zimbabwe and Malawi, and with maize in Zimbabwe and Zambia.

The first of the experiences in reforming the national research system in anglophone Africa was perhaps the Ghana experience of the creation of a national research system in the form of a National Academy of Science, with research institutes and organizations in primary, secondary and tertiary agricultural industries, including the:

- Cocoa Research Institute of Ghana (CRIG);
- Crops Research Institute, Kwadaso (CRI);
- Soils Research Institute, Kwadaso (SRI);
- Aquatic Resources Research Institute (ARRI);
- Food Research Institute, Accra (FRI);

and other publicly funded research institutes that were created or organized later. The historical development and evolution of these institutions are documented by Agble (1980)*. Later, the Academy was transformed to a Council for Scientific and Industrial Research (CSIR) which, as an umbrella council, was charged with the responsibilities for policies, priorities, resource allocation, management and direction of the institutes.

5. Contemporary Research Institutions and Systems

5.1 National agricultural research system (NARS)

A NARS is commonly regarded as a complex of institutions and mechanisms that bring physical, human, financial and information resources together and manage them to address the problems of agriculture and to generate outputs to improve the production and productivity of commodities and the resource base. This definition of NARS focuses on institutions and mechanisms, resources, problems and output, and emphasizes the continuum in the research process from diagnosis, problem definition or opportunity identification, through the organization of research, to the delivery of the output, information and conclusions that would influence agricultural production. Structurally, a NARS therefore comprises government institutions, universities, private-sector research institutions, research units or projects, parastatals, and leading farmers who are involved in some of the functions of the research process. It therefore follows that NARS should also have a "management culture" that would facilitate the research process and the effective delivery of the outputs of research.

5.2 Types and numbers of agricultural research institutions

A variety of types and numbers of research institutions have now evolved and constitute contemporary NARS in anglophone sub-Saharan Africa. The most notable types among these are:

* Agricultural Research in Ghana by W.K. Agble SAREC Report RI: 1980. Strengthening National Agricultural Research. Ed. B. Bengtsson & G. Tedia.

- (i) Semi-autonomous research councils - These are exemplified by councils or organizations such as the Council for Scientific and Industrial Research (CSIR), which has under its aegis eight major institutes and stations in the agricultural sector. Four of these institutes can be classified as multi-commodity, one single-commodity (oil palm), two are factors (soils/water resources), one is single discipline (Aquatic Biology), and the Food Research Institute, which is both multi-commodity and agro-industrial. Although these represent a substantial part of the agricultural research effort, they do not constitute the entire NARS. There are other institutes, such as the Cocoa Research Institute of Ghana (CRIG); the Forest Products Research Institute (FPRI), which is a national successor of a former inter-territorial or regional research organization; the Ghana Atomic Energy Commission, and two boards responsible for research and development in grain legumes and in timber; the universities; and other projects under the Ministry of Agriculture (Figure 1).

The Agricultural Research Corporation (ARC) of the Sudan is in a similar category and is discussed under West Asia and North Africa (WANA). Also, in Nigeria in the late '60s and early '70s an Agricultural Research Council (ARC) was set up, under the National Council for Science and Technology (NCST), to coordinate, organize and manage the complex of agricultural research institutes created from the then Federal Department of Agricultural Research and some related regional research institutions. It was, however, short-lived and was succeeded by the National Science and Technology Department Agency (NSTDA) which essentially merged the NCST and ARCN into a development agency with funding, supervisory, organization, and some management responsibilities. The activities of these councils ranged from policy guidance, priority setting and global allocation of resources for research, to research management, but by and large, responsibilities for planning and execution and management of the research programs were accorded to the institutes that came under them. In other words, the councils concentrated more on policy guidance and direction, and on funding. The institutes or stations enjoyed considerable autonomy in the organization and management of research within the confines of the budgets allocated by government through the councils or as a result of council's interventions and negotiations. The councils in these cases served as the apex bodies of the NARS in the country. They are more like the funding councils of Asia but they have some responsibilities in research coordination.

There are some other semi-autonomous agricultural research councils in sub-Saharan Africa, but these play advisory roles to government, as is the case in Zimbabwe, where an ARC was created by statute in 1973, with provisions:*

"to keep under review agricultural research in Rhodesia....."

"to promote all aspects of agricultural research....."

"with the approval of the Minister, to carry out agricultural research";

is now purely advisory to government and to the Ministry-based Department of Research and Specialist Services (DR&SS).

* The Statute Law of Rhodesia. Government Printer, Salisbury.

An Agricultural Research Advisory Council was also set up in Kenya in 1969 to advise the Minister of Agriculture. But again this was short-lived and was later replaced by the Kenya Agricultural Research Institute (KARI) established under the Science and Technology Act of 1979.

In general, it can be said that the council model did not take root in sub-Saharan Africa in the same way that it did in Asia. The only exception is Ghana, where even more recently it was found necessary to recommend the establishment of a senior body to formulate national agricultural research policy, based on merging national science and technology policy with national agricultural development policy. The body would establish the national agricultural research strategy and would have authority to decide on major priorities for agricultural research. Eventually this senior body is likely to become the apex body for strategic planning and coordination of agricultural research in Ghana.

- (ii) Semi-autonomous research institutes or organizations - These institutes or organizations combine the powers and responsibilities of the councils and the component institutes above. There may be one in the country or a number in specific disciplines, commodities or geographic/ecological areas. They receive grants and allocations from government and other sources and are managed by boards of management designated by government or by a responsible ministry, but in practice such management is confined to policy management, direction and guidance as regards finances, personnel, program priorities and general development. The detailed planning and execution of programs and the day-to-day management are directly under the director general or director of the institute or organization. Of the 17 NARS considered in this overview, three of them feature this semi-autonomous research institute model. These are Kenya, Ethiopia, and Nigeria, and if Cameroon is considered, the Institute of Agricultural Research (ISAR) and its livestock counterpart would also come under this category.

In Kenya, the Kenya Agricultural Research Institute (KARI) was created under the Science and Technology Act, which created other national research institutes in the fields of industrial research and allied technology, marine and freshwater fisheries, medical research, trypanosomiasis research, and later in forestry. Each institute was assigned a responsible ministry, which initially was Agriculture for KARI, but became the new Ministry of Research, Science and Technology, following the cabinet reshuffle and reorganization of the ministries of the late '80s.

The special features of the semi-autonomous institute can be found in the functions* defined for KARI by law:

- "a) to carry out research in the fields specified (agriculture, veterinary sciences);
- b) to cooperate with other organizations and institutions of higher learning in training programmes and on matters of relevant research;

* The Science and Technology Act. Chap 250. Laws of Kenya, Government Printer, Nairobi.

- c) to liaise with other research bodies within and outside Kenya carrying out similar research;
- d) to disseminate research findings;
- e) to cooperate with the responsible Ministry, the Council (NCST) and the relevant Research Committee (ASARC), in matters pertaining to research policies and priorities;
- f) to do all such things as appear to be necessary, desirable or expedient to carry out its functions."

I have quoted these functions in extenso to emphasize the degree of autonomy accorded KARI by law to organize and manage agricultural research in the country. Indeed, it also shares responsibility with the responsible ministry in matters of policies and priorities. We refer to this status as semi-autonomy because it does not fund itself and depends on the national treasury to provide its funds through the responsible ministry. An important provision in the law among the functions of the Board of Management is the function "to receive, on behalf of the Research Institute, grants-in-aid, gifts, donations, fees, subscriptions or other moneys and make disbursement therefrom;" The Board inter alia makes regulations governing appointments and discipline, draws up a scheme of service, appoints staff, and administers approved terms and conditions of service for the Institute.

The Board and the institute share considerable powers between them, making semi-autonomy quite attractive in the effective organization and management of research.

In organizing to carry out the functions envisaged, KARI structured and organized itself into three departments of crops and soils, livestock, and planning, finance and administration, each headed by a deputy director (Figure 2). A network of national (commodity/factor) research centers and regional (production systems) centers was developed under the deputy director (crops and soils) assisted by three assistant directors (perhaps four now). Animal production and animal health research, as well as their inputs into RRCs, came under the deputy director of livestock. The third department focuses on planning and manpower development, finance and administrative and support services (Figure 2). The directorate, comprising the director, deputy directors and assistant directors, constitutes the senior technical group that provides leadership to the centers' planning and programming, and prepares information for the research and technical committee of the Board for its deliberations on priority setting and resource allocation. This system has proved to be effective when worked consistently and with systematic mechanisms for the functions in the research process.

Many of the features in the Kenya law apply to the semi-autonomous institutes in Ethiopia and in Nigeria.

The order establishing the Institute of Agricultural Research (IAR) in Ethiopia in 1966 gives a national mandate for research in agriculture to the institute. As a semi-autonomous, public organization, the institute was established to:

- formulate a national policy for agricultural research;
- carry out research programs;

coordinate agricultural research programs carried out by the various organizations in the country.

Under the general supervision of a Ministerial Board of Directors IAR carries out policy formulation, research program planning and execution, and research coordination. The Ministerial Board of Directors is chaired by the Minister of Agriculture, and in that sense IAR differs from the present-day KARI in Kenya. However, it is similar in carrying out functions in the policy, priority setting, program formulation and execution areas, and in the coordination of research. IAR is headed by a General Manager (similar to the ARC of the Sudan) assisted by three deputy General Managers in the research support, research/extension, and business and development (administration and infrastructure) areas. There is a mix of commodity and regional research stations committed principally to the organization and execution of the research programs at appropriate locations throughout the country. Also, in this case, the semi-autonomy is exercised on the basis of the funding and resources allocated to the Institute through the Ministry of Agriculture.

The case of Nigeria features a complex of 20 semi-autonomous research institutes, three of which are industrial or agro-industrial, and seventeen agricultural. Of these seventeen, three are multi-commodity and systems oriented; seven are single commodity or group of commodities, e.g., oilpalm and cereals; three are in animal production and animal health; two in fisheries (marine and freshwater) and one each in storage and research/extension liaison (Table 3). Each institute was established under an act or decree (Nigerian Institute Act 1964, or Establishment Orders of the 1970s). As indicated earlier, they were managed initially under an Agricultural Research Council, came under the NSTDA, and were eventually placed under the Federal Ministry of Science and Technology (FMST) when it was created in 1979. Although FMST is the responsible Ministry and coordinated the activities of the research institutes, the institutes retained their semi-autonomy, with their individual Boards made up of the clients and stakeholders of research, and relative freedom to organize and manage research within the mandate and resources agreed with and provided by the FMST. The Ministry exercised guidance through periodic policy communications to the Institutes, membership of the Boards, and more importantly, through the allocation of funding from the Federal Government.

The Nigerian agricultural research institutes are currently experiencing funding problems, mainly due to gross imbalance between personnel and operating costs. These will be discussed later.

In eastern Africa, Tanzania, which hitherto had had a Department of Agricultural Research in the Ministry of Agriculture, embarked on the trend for the creation of semi-autonomous research organizations in the early '80s. In 1982/83 the Tanzania Agricultural Research Organization (TARO) and the Tanzania Livestock Research Organization (TALIRO) were created. From the outset this attempt was fraught with difficulties over the separation of crop agriculture and livestock into two independent research organizations with no satisfactory linkages and with little or no specific provisions to ensure that they served the agricultural

Table 3: The Complex of Nigerian NARS 1989/90

INSTITUTE	MANDATE	HEADQUARTERS	TYPE
Institute of Agricultural Research (IAR)	Sorghum, groundnuts, cowpeas, sunflower and farming systems in northern Guinea savanna zone.	Samaru, Zaria (Kaduna)	Multi-commodity
National Cereals Research Institute (NCRI)	Rice, soybeans, beniseed, sugarcane and farming systems in the northwestern Chad basin.	Badeggi (Niger)	Commodity
Lake Chad Research Institute	Millet, wheat, barley and farming systems in the northwestern Chad basin.	Maiduguri (Borno)	Multi-commodity
Institute of Agricultural Research and Training (IAR&T)	Maize, kenaf, jute. Coordination of research in soils, soil fertility, fertilizers, and agro-chemicals. Farming systems in the south-western savanna and forest zone.	Ibadan (Oyo)	Multi-commodity
National Root Crops Research Institute (NACRI)	Cassava, yam, cocoyam, Irish potato, sweet potato, ginger. Farming systems in the south-eastern forest zone.	Umudike Umuahia (Imo)	Commodity
Cocoa Research Institute of Nigeria (CRIN)	Cocoa, cashew, coffee, kola and tea.	Gambari Ibadan (Oyo)	Commodity
Rubber Research Institute of Nigeria (RRIN)	Rubber tree.	Iyanomo Benin City (Bendel)	Commodity
Nigerian Institute for Oil Palm Research (NIFOR)	Oil palm, raffia, dates, coconut.	Benin City (Bendel)	Commodity
Forestry Research Institute of Nigeria (FRIN)	Forestry, agro-forestry, wildlife.	Ibadan (Oyo)	Commodity
National Institute for Horticultural Research (NIHORT)	Fruits and vegetables.	Ibadan (Oyo)	Commodity
National Animal Production Research Institute (NAPRI)	Large and small ruminants.	Shika, Zaria (Kaduna)	Animal Health/ Animal Production
National Veterinary Research Institute (NVRI)	Veterinary research.	Vom, Jos (Plateau)	Animal Health/ Animal Production
Nigeria Institute for Trypanosomiasis Research (NITR)	Animal and human trypanosomiasis, onchocerciasis.	Kaduna (Kaduna)	Animal Health/ Animal Production

Nigerian Stored Products Research Institute (NSPRI)	Storage systems for agricultural produce.	Ilorin (Kwara)	Storage
National Institute for Fresh Water Fisheries Research (NIFWRI)	Freshwater fisheries; ecology and environment.	New Bussa (Kwara)	Fisheries
Nigerian Institute for Oceanography and Marine Research (NIOMR)	Marine/brackish water fisheries; oceanography.	Lagos (Lagos)	Fisheries
Projects Development Institute (PRODA)	Development of technology - industrial and agricultural.	Enugu (Anambra)	Industrial/ Agro-industrial
Federal Institute of Industrial Research (FIIR)	Agro-industrial and food science and processing technology.	Oshodi, Lagos	Industrial/ Agro-industrial
National Research Institute for Chemical Technology (NRICT)	Leather and leather products. Chemicals and chemical products.	Zaria (Kaduna)	Industrial/ Agro-industrial
Agricultural Extension and Research Liaison Services (AERLS)	Coordination of overall planning and development of extension liaison activities.	Samaru, Zaria (Kaduna)	Extension

industry in a coordinated, integrated fashion. The structure and organization of both TARO and TALIRO are presented in Figures 3 and 4. The overall structure and organization of agricultural research in Tanzania in 1988/89 is shown in Figure 5.

Although some provisions were made for research-extension liaison in both organizations, over the years, it was alleged that the organizations became far removed from the client ministry and ostensibly from the farming community. They were accused of carrying out research for the sake of research and of the fact that they showed no accountability to the farming community in their work.

Beset with management and funding problems, both TARO and TALIRO were abolished in 1988/89, their assets were turned over to a Department of Research and Training in the Ministry of Agriculture, thereby reverting to a Ministry model. The new Department is in the throes of organizing itself to take full responsibility for integrated agricultural research throughout Tanzania through a network of six or seven zonal research centers. A detailed research plan is in preparation, and external funding is likely to be forthcoming to rehabilitate and consolidate the research functions within the structure and organization proposed in Figure 6.

It should be noted that apart from TALIRO and TARO, other semi-autonomous research institutions existed in Tanzania at the same time.

These included the Uyo Agricultural Center (UAC) (funded mainly from external sources), the Tropical Pesticides Research Institute (TPRI), and a number of research and development projects in agriculture. The structure and organization of UAC and TPRI are shown in Figures 7 and 8.

- (iii) Autonomous advisory and coordinating councils - These types of councils were set up in many countries in sub-Saharan Africa in the '70s and early '80s on the advice of United Nations bodies. The aim was to focus on science and technology for development. These councils are exemplified by the National Council for Science and Technology (NCST) in Kenya; NCST in Nigeria; National Council for Scientific Research (NCSR) in Zambia; National Council for Scientific and Industrial Research (NCSIR) in Zimbabwe; and were mainly advisory to government on science and technology policies. Attempts at coordination were principally through advice to government and the institutes concerned. They did not have research institutes directly under them, although some, like the NCSR in Zambia, carry out some research activities. Some also have limited funds to stimulate and promote scientific and technological research in existing institutes. These types of councils have had very limited or direct influence on the growth and performance of NARS in sub-Saharan Africa.
- (iv) The ministry model - The model of departments of agricultural research in the ministry of agriculture is the commonest in sub-Saharan Africa. This was the original model in most of anglophone Africa before independence, and of the 17 countries reviewed, twelve have this model in one form or another. Botswana, (Fig. 9) Namibia, Malawi, Tanzania, Swaziland, Uganda (before the implementation of the establishment of a National Agricultural Research Organization (NARO) currently under consideration), Zambia, and Zimbabwe all have departments of agricultural research in or of the ministry of agriculture. In The Gambia, although there is a National Agricultural Research Board (NARB), most of the agricultural research is based in or coordinated by a department of agricultural research of the Ministry of Agriculture. Sierra Leone has two agricultural research institutes (Rokpur and Njala IAR) but both are Ministry of Agriculture research institutes. Liberia's Agricultural Research Institute (ARI) and Rubber Research Institute (RRI) are Ministry-based. Somalia has an agricultural research institute based in the Ministry of Agriculture, and in Lesotho agricultural research is a division of the Department of Field Services in the Ministry of Agriculture.

These ministry-based departments or divisions have varying degrees of autonomy in the planning and management of agricultural research from allocations made by the ministry from the agricultural sector budget. For example, the Department of Research and Specialist Services (DR&SS) in Zimbabwe, because of its reputation and history, has a high degree of semi-autonomy in the organization and management of research and, until recently, regularly received adequate funding for its research and specialist services. In some others, such departments are fully integrated in the line ministry of agriculture and often compete poorly for resource allocations with development departments. Semi-autonomy, freedom from strict government bureaucracy, and some flexibility in the organization and management of research, often determine how well such departments can conduct effective research and

product delivery to clients. A major advantage always linked with this model is responsiveness. It is generally felt that such departments, being integral parts of the ministry of agriculture, are bound to be more responsive to the needs of the development departments, and that greater interactions with the extension services and other technology transfer systems are facilitated.

- (v) University-based institutes or departments of agricultural research. This model formally gives responsibility for all or some aspects of agricultural research to a university, university-based institute or department. Examples of this exist in northern Nigeria (Ahmadu Bello University, Institute of Agricultural Research IAR - ABU) and the Sokoine University of Agriculture (SUA) in Tanzania; and Makerere University in Uganda is seeking similar status for its Makerere University Agricultural Research Institute, Kabanyolo (MUARIK). Swaziland tried this model by integrating its Faculty of Agriculture and the Ministry of Agriculture Department of Agricultural Research in the early '80s but has now reverted to separate faculty and department. It appeared that Government was not satisfied that its interests in development-oriented agricultural research were well served by this arrangement. In nearly all cases government retains some functions in a department of agriculture or agricultural research, so that the NARS is partly university- and partly ministry- based. This in effect could be seen as a combination of models (ii) and (iv), where the university brings in the semi-autonomy to provide flexibility for the research process.

6. Functional Aspects of Organization and Structure

Organizations and structures in agricultural research are in place principally to ensure the performance of the essential functions of the research process, including planning, programming, program execution, communication of results, linkages development, monitoring and evaluation, and other aspects of research management:

- (i) Planning and programming: These structures and organizations must therefore be examined in terms of how they facilitate policy planning; especially strategic planning on a medium- to long-term time frame; the mobilizing of physical, human, financial and other resources for research; and the determination of priorities and broad thrusts for research.

These structures must also be examined in relation to their facilitation of short-term program determination, annual programs of research, experiments and studies, that will respond to the policies, priorities, and strategies established in the medium- to long-term plans. NARS with semi-autonomous councils or institutes have been more effective in this area, and strategic plans now exist for Kenya, Malawi, and Somalia; and plans are afoot for strategic agricultural research plan preparation in Tanzania, Rwanda, Zimbabwe, Lesotho and Botswana.

- (ii) Execution: Structures and organizations must also promote and facilitate the carrying out of research activities in terms of logistics, experimentation (field and laboratories), including technology-generating and technology-testing research, leading to conclusions and information. The more semi-autonomous and flexible NARS are usually more effective in this area of execution of research. Major examples are Nigeria, Zimbabwe, Ghana

(in the early years) and more recently Kenya. Ministry models may be equally effective if they have knowledgeable leadership and operate rationalized programs that are not inordinately ambitious.

- (iii) Communication of results, findings and conclusions: Structures and organizations must provide for the communication of research results, findings and conclusions to the immediate clients in development agriculture, and the ultimate farmer and producer clients. The temptation for research to confine itself to publication of findings in scientific or research journals must be resisted, particularly in a developing country where the investment in research is expected to benefit the productive agricultural sector directly and urgently. Most NARS in this region have weak systems for the communication of results and do not seem to pay much special attention to this, although the situation is improving. The ministry departments seem to be more effective than the semi-autonomous institutions in this regard.
- (iv) Linkages: The development of linkages by the research organizations is crucial for the planning of the content and scope research; the execution of research; and the effective communication of results, conclusions and innovations. Such linkages must be developed with input and output relationship considerations with policymakers, extension services, development ministries and agencies, national and international scientific community, and with farmers, producers and processors as ultimate clients of research. Most NARS in the region are redressing the situation of poor linkages with clients, which had developed over the years.
- (v) Monitoring and evaluation: The structures and organizations of NARS in sub-Saharan in many cases make poor provision for the monitoring of ongoing research in a systematic way. Evaluations are rare and also not systematic, but the increasing emphasis on training in the principles and tools of improved agricultural research management is making an important impact in this area, especially in southern Africa, where the ISNAR/SACCAR project continues to make good progress, and in other regions where ISNAR training has focused on this area.

The functions, means and devices for organizing research at different levels in a NARS are summarized in Table 4, and the NARS structure and functions in relation to planning, program formulation, implementation of research and dissemination of results and conclusions, are schematically illustrated in Fig. 10.

7. Research Support Services

The research process involves a variety of support services essential for the generation and dissemination of the outputs of research. Some of the more important ones are:

- (i) Statistics or biometrics/data processing services. These services are crucial to the planning, analysis and interpretation of policies, and experiments, and in most cases form the backbone of experimentation techniques and conclusions. They are not uniformly developed in the countries in this region, but examples such as the Biometrics Bureau of the DR&SS, Zimbabwe, represents a good approach for the support research required through this service. In addition, the Bureau also assists in management information system development.

IAR of Ahmadu Bello University, Zaria, Nigeria, has a similarly effective service and units are developing in other semi-autonomous institutes.

- (ii) Plant and animal identification services are important in establishing the identity of insects, natural enemies, disease organisms, and other agents of disease and disorders in crops and animals. This involves the establishment of an insect museum, disease organism cultures, analytical procedures, and provision of equipment and documentation for reference and identification. These services are relatively well developed in most of the countries concerned, and their activities are backstopped by reference services at such places as the Commonwealth Bureau Institutes of Entomology, Mycology, Helminthology, Kew gardens, in the United Kingdom, and national museums in the United States, France, Belgium, Finland and other developed countries.
- (iii) Plant introduction and quarantine services are research-related in most countries. They permit and should facilitate the safe introduction of new crops, improved germplasm of existing crops, useful natural enemies of pests and weeds, and a whole range of other products that open up new opportunities for the diversification and development of agriculture. These services are well-developed in some countries but not in others. For example, the Muguga facilities in Kenya established under the East African Community has continued to be a major asset to plant introduction and improvement in East Africa; some of the other countries still utilize these facilities. Zimbabwe, Uganda and Tanzania are in the process of inaugurating national services of their own, and in West Africa, Nigeria operates a reasonably good and large service, and small services exist in other anglophone countries of West Africa.
- (iv) Soil Survey, classification, and testing are important in order to plan and realize the potential of the major resource of soil in agricultural production. Soil survey, classification and testing services are therefore well-developed in most countries, with the speed of action varying with the availability of equipment, and competence and stability of staff. Zimbabwe DR&SS provides a good model of such services. KARI also operates excellent services that are well-integrated with soil fertility and soil science research.
- (v) Pesticide analysis, testing and registration are also research-related services because of their importance in crop and animal protection, and the needs for safety in use and environmental quality protection. These analyses take care of the product quality and content, product safety in the context of the farming practices, and degradability in the agro-ecosystems in which they are used. NARS in these sub-Saharan African countries have fairly well-developed services in this area, but there is occasional misuse of pesticides in pesticide management.
- (vi) Seed services are often associated with research, the emphasis being on the production and quality control of breeders' seed and foundation seed, mainly. Seed services also provide field inspection services and laboratory testing for seed production companies and agencies as the basis for seed certification. Good, improved seed can be crucial in any crop development program, and countries like Kenya and Zimbabwe have well-developed systems.

Table 4: Functions, means and devices for organizing research at different levels in a NARS

Level	Functions	Means	Organization
National	•Determining goals and objectives	•Information analysis and exchange	Apex organization Council/Board Science and Technology Development Agency
	•Securing political and financial support	•economic and political dialogue	
	•Advising on development possibilities	•Comparative analysis of development options	Semi-autonomous organization or institute
	Determining policies, priorities and medium-, long-term strategy	Translation of goals & objectives -socio-economic data analysis & interpretation -technical feasibility analysis	Apex organization -Technical Secretariat -Research & Technical Committees and Study teams
	Determining, implementing policies	•Assignment of responsibilities •Broad Resources Allocation •Thrust identification •Coordination	Apex organization -Research/Technical Committees -Other Committees
	Supervising, Monitoring and Evaluation	•Periodic review of organization performance •Monitoring of progress of research thrust •Evaluation of impact of results and conclusions.	Apex organization •Science & Technology Ministry or Development Ministry (Agric. & Natural Resources) •Internal or External Review Groups
			•Planning and Managing Unit/Cell
Institutional	Program Planning	•Review and diagnosis of problems	•Institution management
		•Setting of objectives and goals	•Research directors and managers
		•Reviewing world information and knowledge	•Commodity/system program committees

Continuation Table 4.

Level	Functions	Means	Organization
Institution	Programming	<ul style="list-style-type: none"> •Determining research trusts & relative inputs •Setting priorities within commodities and experimental approaches •Determining and reviewing annual programs 	<ul style="list-style-type: none"> •Institution management •Research Managers •Research Supervisors •Research Review Committees
Institution	Budgeting	<ul style="list-style-type: none"> •Estimate the resources needed 	
Institution	Evaluation	<ul style="list-style-type: none"> •Assessing potential impact of research •Determining time frame for output 	
Institution	Support Services	<ul style="list-style-type: none"> •Plant, Soil, Animal analysis •Quarantine Services - Physical plant services & maintenance 	<ul style="list-style-type: none"> •Physical plant and analytical services
Program (Implementation)	Program execution	<ul style="list-style-type: none"> •Assigning responsibilities for experimentation & studies •coordinating programs & promoting information flow & exchange •Experimentation & studies •Data collection & analysis •Testing and interpretation of results and conclusions •Periodic reporting of findings and progress •Review, monitoring, and evaluation 	<ul style="list-style-type: none"> Institution Management •Research directors/managers •National Program Coordinators/Leaders •Researcher Extensionist •Program teams •Technical and research support staff teams

Nigeria is evolving both public- and private-sector seed services. Some of the smaller countries expand this rôle to include seed production, multiplication and distribution, especially at critical stages of crop introduction or development, or the spread of improved materials.

- (vii) Library and documentation services are crucial to enable NARS to reach out to the world knowledge systems and to document results of research, and exchange information. Such systems are well developed in most countries, the major gap being in abilities to generate appropriate and relevant materials for the major in-country client groups and to sustain these services in the context of foreign exchange scarcities. Many of these NARS need to modernize their services and where appropriate introduce computerized library and documentation services.
- (viii) Maintenance of plant and equipment is an essential service for agricultural research in all the countries under review. Most NARS in the countries concerned have physical plant services (PPS), but they are usually poorly equipped and poorly staffed. There is an urgent need to develop and strengthen a "maintenance culture" in essential support services, if agriculture is to continue to make increasing impact on agricultural production and economic welfare of the anglophone NARS of sub-Saharan Africa. These support services are essential complements to research, and more often than not constitute an integral part of the organization and structure of NARS. Successful services were provided under the East African Community in the '60s and '70s and have been largely sustained under the reorganized Kenya Agricultural Research Institute (KARI). In West Africa, both IAR, Samaru, Zaria, and the Institute of Agricultural Research and Training (IAR&T), Ibadan, provide excellent services in most of these areas. While it cannot be said that these support services should always be integrated with NARS structure, or separated in separately funded service units, their importance to the mission and output of NARS is crucial, and they deserve recognition and attention in any consideration of organization and structure of national agricultural research systems.

8. Application of the Analytical Framework

The analysis so far has concentrated on the historical evolution and context of NARS in anglophone sub-Saharan Africa. Because most of these systems have evolved from a shared colonial experience and have been influenced largely by the "research culture" of the colonial power, they seem to have a lot in common in terms of strengths and weaknesses. Even where some significant divergence has occurred, elements of organizational and management culture reminiscent of the colonial period have persisted.

The most significant characteristics of the systems in this group of countries are their relative "youth" and lack of maturity (nearly all are less than 30 years old and most have only really functioned as research systems in the last 10 - 15 years). At best, they can be considered as evolving systems in which different options are still being tested, and unfortunately under fairly unstable, political, economic and other environmental circumstances. With few exceptions, none of the systems under discussion has retained its organization and structure for more than 5 years at a stretch. For example, in the period between 1962 and 1983, the Nigerian agricultural research system, one of the largest in sub-Saharan Africa, went through the following phases:

- (i) major part of agricultural research in a Department of Agricultural Research (Federal Ministry), state Ministries of Agriculture, and some semi-autonomous research institutes (e.g. cocoa, oilpalm);
- (ii) the creation of a number of semi-autonomous research institutes for single commodities or groups of commodities, and the establishment of an Agricultural Research Council (ARCN) (as a coordinating council with some funding powers);
- (iii) the establishment of a National Science and Technology Development Agency (NSTDA), to replace both the National Council of Science and Technology (NCST) - advisory science and technology policy - and the ARCN. The agency combined the functions of coordinating, funding, and to a certain extent management of the agricultural research activities in the country;
- (iv) the conversion of the NSTDA into a stand alone Federal Ministry of Science and Technology with responsibility for the organization and management of scientific and technological research and its application in development. Ovc. 80% of these activities were in the field of agricultural research;
- (v) the merger of the Ministry of Science and Technology with the Ministry of Education and the transfer of agricultural research responsibilities to the merged ministry;
- (vi) the restoration of the separate Ministry of Science and Technology and its responsibilities for agricultural research through its Agricultural Sciences Research Department.

These frequent changes were so disruptive that, were it not for some stability provided by the individual institutes constituting the system, agricultural research would have suffered irretrievably. All the same, the changes had the most telling effect on the planning and management of agricultural research, the effectiveness and efficiency of research, and on the ability of the system to respond flexibly to the needs of the clients and stakeholders. Some of these effects have persisted and are likely to persist into the 1990s.

Similar events and experiences can be referred to in countries such as Kenya and Tanzania. In Tanzania, the system has moved from a Ministerial Department of Agricultural Research at the beginning of the '80s to two parastatal organizations (TARO and TALIRO) in the middle of the '80s, and now back in 1989 to a Department of Research and Training in the Ministry of Agriculture and Livestock Development. In Kenya, while the concept of the Kenya Agricultural Research Institute (KARI) has managed to survive since 1979, for the most part the concept only survived in name and only on paper. It was not until 1985/86 that the agricultural research services of the Scientific Research Divisions of the Ministries of Agriculture and Livestock Development were combined with the Muguga and other research facilities to constitute the KARI in composition and function as envisaged in the Science and Technology Act that created KARI. Despite all that, the reorganized KARI was bedevilled by the question of ministerial alignment and for a long time was tossed between the Ministry of Agriculture and the Ministry of Research, Science and Technology, with some unsavory effects on its planning,

programming and management functions in research. Some of these experiences have been referred to here in order to emphasize the evolving mode of NARS in anglophone Africa and to signify that experimentation with organizational options is a continuing exercise. Any conclusions reached in this analysis must be seen in this context. More reliable answers to some of the questions, and reactions to some of the issues, would have to await future observations on the effects of organization and structure as the systems stabilize and become more amenable to the application of our analytical framework.

Our analytical approach to organization and structure assumes that the "Research Organization" should provide a context for the transformation of human, financial, physical and information resources into research products of benefit to the clients and stakeholders of research. This presupposes the application of management and linkage functions in this transformation. The question is to examine how and why certain types of structures organization facilitate, or impede, the performance of the essential functions of research in the most effective and efficient way. Some of these research management and linkage functions are summarized in the Analytical Framework (Sachdeva, 1989) as including system governance, strategic planning, program planning, programming, implementation, monitoring, reviewing and evaluation. In essence, the effectiveness of the research system will largely hinge on how these functions are performed and on the policy, strategic and management environment that influence these. Functional criteria are of key importance in the determination of appropriateness or inappropriateness of an organization and structure and should be able to guide countries in the selection of options.

In Section 5 five types of research organizations are shown to characterize the systems in anglophone sub-Saharan Africa. A functional analysis of these types in relation to effective research management at the national, institutional and research station (field operational) levels indicates that they vary tremendously in performance and in the circumstances that have established and retained them as the basis of the countries' efforts in agricultural research.

The following analysis only highlights some of the strengths, weaknesses, opportunities and limitations. It is hoped, however, that it will serve to focus attention on the critical issues and stimulate discussions that will lead to guidelines in the design and development of organizations and structures that will strengthen agricultural research and the impact of agricultural research in anglophone sub-Saharan Africa.

A. System Governance

Semi-autonomous research councils, provided they receive the support and can retain the listening ear of government, are usually effective and successful in securing domain legitimacy for agricultural research. With the legal and moral backing of government, they are, usually within reasonable limits, able to advance the political and financial causes of research and to assure the establishment of linkages with all concerned ministries, agencies, donors, clients and other users and stakeholders in research. The degree of success often depends on the level of priority government assigns to agricultural research, not as lipservice, but as a true instrument of growth and development, and also to the effectiveness of the council in making watertight and convincing cases to government and its associated apparatus.

Experiences in Africa indicate that such councils are usually quite effective in the first few years of operation, partly because of their novelty and the desire to make them active and productive. However, unless they use this period to build up a capacity to establish and maintain a continuing interest in research within the government apparatus, through strategic thinking and planning, and the development and pursuit of policies that are recognizably responsive to national development needs and priorities, they progressively lose their clout and recognition and could easily, within 5 years or less, become an obscure part of the burden of parastatals that are to be found in large numbers in many African countries.

The composition of and representation needed for such councils to ensure clout and relevance in the national context cannot at the same time provide for the time and expertise necessary for it to assume major responsibility for the direct initiation and determination of research policy, objectives and strategy. In other words, it is too much to expect that the group of distinguished persons in government, the scientific community, the clientele, and the agricultural industry to constitute such a council would have the time and the depth of exposure and experience to engage in direct work leading to the formulation of policy and the determination of program strategy. This emphasizes the need for such a council to have a technical secretariat that can undertake the fundamental studies and analyze the data and information on which policy considerations can be based and informed judgements made on priorities and program strategy.

The council as the apex body needs the legal status, authority and linkages to facilitate these processes and needs to be supported in developing these. Organization at the council level and the sub-structures (committees, task forces, study teams with appropriate membership) would also enable the council to make full use of the technical secretariat and the products of its investigations and analyses.

A major discrepancy in the operation of councils in Africa is the tendency to constitute them as a detached and distinguished group of scientists and technologists. Such a group may have few, or very tenuous, linkages with the agricultural industry, insufficient appreciation of clients' needs and circumstances, and little direct influence on the apparatus of government. Councils of this type often become "ivory towers" that are given freedom of expression but are hardly listened to or taken seriously in operational circles. Most of the national councils of science and technology in anglophone Africa fall into this category; they are tolerated but hardly listened to.

Examples include the NCST in Nigeria in the '70s and the NCST in Kenya in the early '80s. Attempts to correct this in Nigeria, a predominantly agricultural country, by electing a permanent secretary for agriculture as the council's chairman was not entirely successful. His other duties prevented him from providing the desired leadership, and the linkages required to transform the Council into an effective policy and coordination instrument with access to and influence on government policy did not materialize.

For the functions of organizing the implementation of strategy, determining the mechanisms for inter-institutional collaboration, and guiding the component institutions in the determination of responsibility and use of authority, councils with good technical support and with the full backing of the stakeholders are usually quite successful. However, weaknesses persist in the areas of monitoring and evaluating the strategy.

evaluating the strategy. These weaknesses relate to the establishment and use of reliable mechanisms for monitoring, review and evaluation and exist whether the NARS have a council-type apex body or comprise semi-autonomous institutes, ministerial departments, advisory bodies or university research institutes. The assumption is that once the priorities and programs are agreed, the component institutions would do the monitoring and evaluation and would justify the investment being made in them to undertake research. What seems to be missing is the need for some independent, detached evaluation, in a broader perspective that maintains a consciousness for relevance of service to the clients and accountability for the use of funds and other resources. In the Nigerian institutes research review of 1981 the suggestion was made for periodic reviews of institutes, but no such reviews have taken place since then.

Semi-autonomous research institutions and organizations are generally more effective in the area of organizing the implementation of strategy and determining and executing the mechanisms for program formulation, program collaboration and coordination, and in assigning responsibilities and authority at the program level of governance. They in turn need a knowledgeable board of management that recognizes its functions of policy guidance, priority determination, and sub-global resource allocation, and does not trespass into the territory of management which should be the proper responsibility of the senior and middle-level managers in the institutes. Again, such boards need the technical support to be provided by senior management of the institute through studies, strategic analyses, and the presentation of data and options that would enable the boards to make rational decisions and offer effective guidance on strategy.

B. Institutional Program and Administrative Management

The various organizational options available at the institution level have a very profound influence on the effectiveness and relevance of research. A most important and critical consideration in the selection of options is the expected output from research and the extent to which this output should be relevant and applicable to the needs of the primary clients. If it is kept constantly in mind that the purpose of agricultural research is to service the agricultural industry, then it would be clear how and which options should be selected and for what purpose. In the final analysis a combination of options may be selected to serve different aspects of this purpose.

The framework focuses on options that relate to a commodity or commodity groups, a discipline or group of disciplines, factors of production, program or project, geographical area (agro-ecological or administrative), or some combination of these. These options can be made to fit into the council model, the semi-autonomous model and the ministry departmental model, or the university/government department model. Although the semi-autonomous research institute has a special advantage in its ability to direct the planning and management of research in a meaningful combination of these options to address the evolving problems and challenges in the agricultural sector, others may also be able to do so if properly directed. The semi-autonomous council model can only facilitate the selection of the combination of options at the institute level by giving well-reasoned policy guidance and indications of priorities, but the institutes themselves have to determine how the research product to address the identified problem should be researched - either on a commodity, discipline or factor basis, or whether the state of technologies was such that these should be combined in an integrated system to generate the packages required by the clients.

In many cases of agricultural research, inter-disciplinary research is often necessary in addressing production problems. This is because production technologies usually have many components, some of

which have to be researched separately or individually but which must keep the focus of the client's requirement. The program mode or option has the advantage and flexibility of bringing the required disciplines together to address a problem, whether the problem is in respect of a commodity, a geographical area, or factors of production. The flexibility ensures that only disciplines required as per the definition of the problem are brought together for the necessary research activity, so that there are no rigid disciplinary compositions, and disciplinary resources can be diverted to address other problems as soon as the initial ones are solved. The program objectives have to be clearly defined and the expected output and timeframe required determined. Under these circumstances the program can be kept focused and its output made relevant.

The program option, because of its ability to combine some of the other options and to keep in focus the output of research, has been the preferred option at the institution level in many systems in recent times. There is no doubt that it has facilitated the pursuit of relevant research and the development of appropriate technologies. It has also encouraged the inter-disciplinary approach required in the planning and execution of client-oriented or problem-oriented research. The semi-autonomous national research institute model, in view of its coverage of ranges of commodity, factors and disciplines, has used the program option most effectively. It must be admitted, however, that the program approach is a relatively recent development in many systems in anglophone Africa and it has special problems of organization and management. In particular, it depends on the careful planning of the subject for research, effective leadership in defining program objectives and required inputs, and effective supervision and monitoring to ensure that the output is kept in focus and relevant to the needs of the clients. It also requires that resources be allocated in such a way that the program can function without undue bureaucratic constraints. For example, conflicts often arise if programs are agreed and approved as the basis of operation and the resources are allocated to administrative or technical sections that have no real understanding of or involvement in the program approach. This is an issue on which analysis and discussions should focus, based on the experiences of managers from various countries.

The discipline, or group of disciplines, option is perhaps the most difficult to manage in the context of research expected to generate and develop technologies for farmer and producer clients. There is often the tendency for disciplinary research to focus on the development of the discipline rather than on component contributions of the discipline to the technology base for problem solving. Systems that have preserved the disciplinary approach often have the problem of integrating outputs of research into meaningful technologies that are problem-solving and client-oriented. Managers need to be careful to keep the focus of the disciplinary research on the priority problems and to prevent them from going off on tangents to pursue problems of mere agricultural or scientific interest, or the interests of the scientists.

The university model, in view of its usual disciplinary organization, has often adopted the disciplinary option even in problem-oriented research. Unless managed tightly, by keeping the problem in focus and perhaps tying the resources to specifically required disciplinary components, the approach may hinder rather than facilitate responsiveness in research. The problem is further complicated by the fact that universities are usually more concerned about the issue of autonomy and attempts to manage research tightly and with a problem focus may be interpreted as interference in institutional autonomy or academic freedom. By and large, the disciplinary option is often more responsive and productive in the areas of strategic and basic research than in applied and adaptive research. The university-type organizations that have succeeded in technology development and problem-oriented research have often had to superimpose the program option and focus on their organization and structure so as to provide a mixed or matrix system necessary to generate the output and impact considered desirable.

Research focusing on geographical areas or agro-ecological zones is more characteristic of ministry agricultural departmental models. Very often the major consideration is on the balanced development of the regions in the country and the responsiveness of research to the specific needs of farmers and producers in these areas. They have the advantage that government administrative organizations can be used to support such research and to move the output fairly rapidly to the users, in both the adaptive and testing stages. Adaptive research requires interdisciplinary inputs and close collaboration with a variety of agencies. Flexibility in planning, organization and management is important if the principal objective of being an instrument in regional or zonal development is to be achieved. Many semi-autonomous institute systems are adopting this approach in dealing with some areas of their mandate, which includes both applied and adaptive research. Also it gives them the opportunity to collaborate with agricultural development agencies in the field; it facilitates the development of emphasis on the diagnosis and definition of client problems; and it gives a better chance of demonstrating impact. A major problem is that regional or zonal option approaches often have difficulties in defining their mandate or in translating their mandates into programs, partly because they are used to the operation of sectional or disciplinary programs, and partly because of insufficiency of attention as to what might be the output of the interdisciplinary research and what would be necessary to organize and implement the research for such an output. The Regional Research Centers (RRCs) of Kenya, the new Zonal Research and Training Centers (ZRTC) of Tanzania, and the stations that are being strengthened in the various natural regions of Zimbabwe combine this option with the options of program, commodity and discipline research in some cases. We should look up to them for experiences in program management that would improve performance.

C. Research Station Level

Organization and structure at the research station level in most anglophone African countries relate mainly to the mandate of the research stations. In general, the most important problem is that usually there are too many research stations. Research stations have developed haphazardly in the past, without clear guidance about the criteria for research station development, and with overlapping mandates. The most urgent question in sub-Saharan Africa is the rationalization of the research station network so that a basis for a cost-effective and efficient NARS can be established. In a large number of cases the most important consideration is the development of a network of priority commodity research stations and regional stations in broad agro-ecological zones. These latter respond effectively to the needs of the agricultural industry and their priorities in these zones. A set of such criteria was considered in preparing the Kenya National Agricultural Research Strategy and Plan (1985).

In practice, research stations may have disciplinary, commodity or geographical area focus, but more often a combination of these. In all types of institutional organizations, provisions must be made for the development of research stations because they represent the basic infra-structure for research activities. It is important, however, that they not be seen merely as a physical presence or amenity but as active centers of research work that are meaningful and responsive in the context of agricultural development. Whether they are many, or only a few, the issue of coordination will always be present and important. Coordination can only be effective if there has been effective cross-disciplinary planning and there is a good flow of communication and information and feedback within the system.

In addition to defining mandates for a network of research stations, some countries have introduced nationally coordinated research programs (NCRPs) as a linkage mechanism for a number of collaborating research stations. However, the most important raison d'être for NCRPs is the need to focus attention on high-priority problems of national importance, and to focus the expertise that exists and is functional in various research stations in the system on such a problem for rapid solution. The most successful NCRPs have therefore been in the areas of breeding and variety development and testing, rather than in the areas of crop management and agronomic practices.

NARS in anglophone Africa are finding that NCRPs are difficult to organize and manage. The experiences and issues arising from their introduction and management would be important in seeing the way clearly towards increasing the effectiveness and impact of research station networks. The lessons from other countries show that the benefits far outweigh the difficulties, and it is important that innovative approaches in management be discussed and considered in bringing about the maximum impact of national coordination and collaborative research.

9. Major Lessons

The description and analysis of structure and organization of agricultural research in the previous sections highlight the fact that there is great diversity in the organization of effective and responsive agricultural research in Africa. No one system or model seems to be perfect and there are important exogenous and endogenous factors that determine effectiveness in carrying out the essential functions in the research process. Also, structures and organization, that appear to be effective or have inherent potential under certain circumstances may lapse into ineffectiveness and provoke drastic measures of restructuring and reorganization. However, certain major lessons can be learned from the evolution of NARS in sub-Saharan Africa when considered in the context of the analytical framework. The most important of these are:

- (i) that research must follow the guidance of policymakers if support and promotion are to be guaranteed. Research needs to be close, and to be seen to be close to policymakers and responsive to policy guidelines provided by them. In this context, accountability is a major issue and can only be measured by some evident impact;
- (ii) that semi-autonomy, though desirable, if it is not well-managed can lead to isolation of the system and eventually to decreased support. Semi-autonomy is more meaningful when it is utilized to create greater flexibility for research to respond to development and clients' needs and not vaunted as independence and freedom to pursue research as determined and prioritized by researchers themselves, and without due regard to the development objectives and aspirations of the stakeholders. It is clearly possible to achieve scientific research excellence without being strictly relevant. It is therefore important for semi-autonomous research institutes to combine relevance with scientific excellence. Semi-autonomous institutes need to cultivate development ministries and agencies of government, as well as farmers as important clients and stakeholders;
- (iii) ministry models of ministry of agriculture-based research departments, where research is closely knit with the development focus and strategy of the ministry, seem appropriate and predominates in many countries of sub-Saharan Africa. The model is particularly appropriate and widely adopted for the small countries. Intrinsically, the model seems to provide for close relationships between research, development strategies, and technology transfer systems.

A major reservation is the possibility of diversion of essential funds for research into development where there are no clear demarcations for resources allocated to agricultural research and allocation and utilization of resources are made in fully integrated line ministries. This limitation can be avoided by the form of arrangements that grant relative semi-autonomy to the department of agricultural research. The organization and management of research becomes entirely departmental once the required resources are allocated; this is exemplified by the DR&SS in Zimbabwe and the DAR in Botswana.

- (iv) The widely adopted ministry model still requires that research should pay special attention to functional linkages with the extension services and technology transfer systems, and with policymakers. Mere existence within the same ministry, or even as branches of the same department, as in the Zambia Department of Agriculture, with an Agricultural Research Branch and an Agricultural Extension Branch, does not guarantee functional effectiveness of linkages and the dissemination of research results. Zambia resolves this through organization and management, as shown in Figure 11.
- (v) Instability due to frequent changes in models and in the alignment of agricultural research with responsible ministries can be detrimental to the functional effectiveness of a research system. Some African countries did not try their models for sufficiently long enough to determine the basis for viable changes. Nigeria and Tanzania are examples of NARS that need stability in their structure and organization to be able to perform the essential functions of the research process.

10. Types of Governance

Since the vast majority of NARS in sub-Saharan Africa are of the ministry model (Table 5), system governance in them follows similar patterns. The departments and divisions of research are like other departments, subject to the tradition and bureaucracy of a line ministry. They may have high or low visibility and contribute to policy dialogue in the ministry, depending on the status ascribed to research. They are not, however, provided for by specific legal instruments and may be structured and reorganized at will and as considered appropriate by the ministry. The exceptions are when by tradition and practice a considerable degree of semi-autonomy and flexibility are granted to them in the organization and management of research.

The councils and semi-autonomous research institutes are established by legal instruments; e.g., acts, statutes of parliament, decrees, and other legal orders. Such acts make them legal bodies and state in detail their mandates, functions, powers, responsibilities, accounting, and accountability procedures. The membership of their boards and committees, and the powers of these constituent organs, are also specifically provided for. Such legal provisions are in practice essential in ensuring that councils and institutes are able to organize and manage research without undue interference. They have in some cases prevented or deterred governments from making unnecessary and disruptive changes in the organization of research.

11. Areas of Research Covered

NARS in sub-Saharan Africa frequently cover the areas of crops and livestock in their institutes, departments, or divisions. Such coverage ranges from comprehensive coverage of food crops, livestock, export crops, forestry, and farming systems, as is the case in the DAR of Botswana; to individual coverage

Table 5: Structure and Organization Models of NARS in Sub-Saharan Africa*

Country	Semi-autonomous Research Council	Semi-autonomous Research Inst./Organization	Autonomous Advisory Coordinating Council	Ministry Department Div. of Agric. Res.	University based Institute/Department
Botswana					
Ethiopia		X		X	
Gambia (The)					
Ghana	X			X	
Kenya		X			
Lesotho					
Liberia				X	
Malawi				X	
Nigeria		X		X	
Namibia					X (also)
Sierra Leone				X	
Somalia				X	
Sudan	X			X	
Tanzania					
Swaziland				X	
Uganda				X	
Zambia		X (under consideration)		X	
Zimbabwe				X	

* Only the dominant structure/organization is indicated.

of crop commodities, animal production, animal health, forestry, fisheries, farming systems and agro-industrial research in separate institutes in the complex of agricultural research institutes constituting the Nigerian NARS (Table 3).

In Kenya, crops and livestock agriculture, forestry, and fisheries are in separate national institutes, whereas in some countries animal health and veterinary research are in separate institutes or departments.

A major observation is that in the ministry model, which is widely adopted in Africa, agricultural research is often fragmented because of the multiplicity of ministries. It is, therefore, often the case that you have a department of agricultural research in the ministry of agriculture; forestry research in the ministry of environment, range or forestry; and animal production, animal health, and fisheries research in a ministry of animal industry or animal resources. Such fragmentation leads to some loss of opportunity for systems and integrated research which is often necessary for the development of appropriate technologies for farmers and producers.

Another set of exceptions in coverage are the special export commodities, such as coffee, tea, cocoa, and rubber. Research on such commodities is usually not covered in the national agricultural research institute or departments. Kenya, Nigeria, Ghana, and Malawi have separate research institutions for coffee, tea, cocoa, and rubber. This situation is due partly to historical reasons and partly to the organization, management, and funding arrangements that have kept these institutions close to their producers and the industry. Kenya supports two Research Foundations,* one in tea and one in coffee. Both of these are funded from cesses on the two commodities. In the review and planning of the NARS in Kenya, the two foundations were found to be adequately funded and well managed for development-oriented research. It was, therefore, considered unnecessary to disrupt their activities and relationships by including them in a comprehensive national agricultural research institute.

Cocoa had a similar relationship to the cocoa industry and the Cocoa Marketing Boards in West Africa in the '60s and '70s; and tobacco is separately supported by the Tobacco Research Board in Zimbabwe. In other countries, research on such special commodities is often separately organized and managed under specific projects; e.g., coconut in Tanzania.

It is clear that comprehensive coverage of all areas of research is not necessary for an apex organization in NARS, but a balance should be sought between extreme fragmentation and consolidation or integration. This is necessary for improved efficiency and effectiveness of NARS. For example, Uganda is in the process of considering the consolidation of its research services in crops, livestock, forestry, and fisheries in a comprehensive national agricultural research organization (NARO). This is expected to be more cost-effective and efficient.

12. Functions and Responsibilities of an Apex Organization

As indicated above, the functions and responsibilities of apex organizations are usually explicitly stated in their enabling acts or decrees. These include the organization and execution of research in mandated areas, liaison with other research bodies, dissemination of results, and the management of the programs and the means of carrying out research. The functions of the boards and their support organs and

* Research Foundations in Kenya are like single-commodity institutes.

committees are also often stated. It has been found highly desirable and indeed essential to include the senior managers of the user ministries and other clients and stakeholders of research in the governing Boards of such apex organizations in Africa. While it is useful to have some distinguished scientists on the boards of such institutes/organizations, the setting up of high-powered boards with a majority of distinguished scientists from outside the system has not been very helpful in the development of NARS.

Most NARS in Africa cover the areas of strategic, applied, adaptive, and technology-testing research in their mandates. A few also cover aspects of basic research, but most of the basic research is undertaken in universities.

In organizing for implementation, sub-Saharan NARS operate through different types of research institutions. These range from single-commodity/discipline research institutes to multi-commodity, system-oriented, national and regional centers of research. These various types are represented in the Nigerian complex (Table 3). Kenya, for example, has a complex of 11 national and 6 regional research centers and 4 with dual national and regional mandates. These national research centers work on single commodities/groups of commodities or factors, such as maize, sugarcane, and soil and water. The regional centers concentrate on production systems involving crops, soils, and animals. Zimbabwe, with a number of disciplinary institutes concentrated in Harare, is now moving to strengthen production systems research in the five natural regions of the country. Tanzania is also likely to adopt the regional focus through its complex of six or seven zonal centers.

The only foundations in Africa are like single-commodity institutes. They are organized to develop and promote specific export crops through research and are generally very effective in doing so. The cases of coffee, tea, and tobacco have been referred to above.

13. Faculties and Universities of Agriculture

Faculties and universities of agriculture have a major role to play in agricultural research in Africa. This is because they possess substantial numbers of highly qualified research scientists and substantial material resources that can be devoted to development-oriented research. Of the 17 countries under review in sub-Saharan Africa, 15 have faculties or universities of agriculture, and nearly all have colleges of agriculture where at least some adaptive and technology-testing research is undertaken (Table 6).

The potential of sub-Saharan African universities in research is not fully realized or utilized, principally because there are no specific mechanisms for effectively linking them to the national research system. Taylor (1988) estimates that in four countries (Kenya, Tanzania, Uganda, and Zimbabwe) an average of 120 person years of research effort would be added to the national systems if the universities were to be involved in national research. In Nigeria alone there are at least 14 faculties of agriculture and two agricultural universities. The Sokoine University of Agriculture in Tanzania has a total of 205 agricultural scientists, constituting about 65% of the total national human resources in agricultural research and training.

The concept of agricultural universities is quite new in sub-Saharan Africa and has not taken root as it has in India. The early attempts in Nigeria to introduce the land-grant university system in the faculties of agriculture at Ahmadu Bello, Ife, and Nsukka did not fully succeed, although some linkages were

Table 6: Universities/Colleges and NARS in
Anglophone Sub-Saharan Africa

Country	University	College
Botswana		Botswana Agricultural College (Faculty)
Ethiopia	1 Agricultural University	X
Gambia (The)	---	---
Ghana	3 Faculties of Agriculture	X
Kenya	3 Faculties of Agriculture	Several colleges
	---	Lesotho Agricultural College
Liberia	1 Faculty of Agriculture	
Malawi	1 Faculty of Agriculture (Bunda)	
Nigeria	(14 Faculties of Agriculture (2 Agricultural Universities)	Several colleges
Namibia	---	---
Sierra Leone	1 Faculty of Agriculture	
Somalia	1 Faculty of Agriculture	X
Sudan	3 Faculties of Agriculture	X
Tanzania	1 Agricultural University	Several colleges
Swaziland	1 Faculty of Agriculture	X
Uganda	1 Faculty of Agriculture	X
Zambia	1 Faculty of Agricultural Science	X
Zimbabwe	1 Faculty of Agriculture	2 Colleges of Agriculture

established with regional research centers in northern, western, and eastern Nigeria, and ABU initially succeeded in integrating the Faculty, Institute, and the Extension Liaison Services in one complex. None of these adopted the strict land-grant system in integrating research, higher education, extension, and services to agriculture. The trend has been for them to revert to traditional European-type faculties of agriculture, although some useful linkages have been maintained.

More recently, Nigeria created two new universities of agriculture (Makurdi and Abeokuta) with a focus on training, research, and service in the south-western and middle belt regions of Nigeria. It is too early to predict how these institutions will evolve, but both seem to be moving towards greater involvement in agricultural development and service in their mandate areas.

Sokoine University of Agriculture (SUA) was created in 1985 and continues to play an important role in teaching, research, and postgraduate education in Tanzania. In Kenya, the creation of a "Research Fund" in Kenya NARS has opened up opportunities of direct involvement of Nairobi, Egerton, and Moi Universities in national agricultural research. Egerton University has had a long tradition of training and service to the agricultural industry in Kenya, and it is hoped that this will be preserved as it achieves fully fledged university status.

In southern Africa, Botswana is strengthening its college of agriculture as a parastatal with a faculty status in the University of Botswana. The college collaborates very closely with the DAR, and the consolidation of this collaboration is expected to strengthen agricultural research and education in the country. Lesotho is considering a number of options for College (LAC) as the basis of a faculty of agriculture or national institute of agricultural research and education of the National University of

Lesotho (NUL). These developments emphasize the need for ISNAR and other agencies to focus attention on strengthening the linkages between universities and other components of NARS in future strategies for Africa.

14. The Role of IARCs

Four of the 13 CGIAR IARCs are located in sub-Saharan Africa and work largely on African agricultural problems. ISNAR, although located outside Africa, devotes approximately 50% of its resources to Africa. In addition, centers like CIMMYT, IRRI, CIP, and CIAT carry out research on some major crop commodities of Africa.

ILCA's mandate focuses on improving livestock production systems in Africa and emphases are on cattle and small ruminants. ILCA collaborates with several NARS in sub-Saharan Africa and, for example, operates a pastures network involving several countries of the region.

ILRAD's mandate is on two major African diseases of animals - East Coast Fever (ECF) and trypanosomiasis. It has achieved considerable success in researching the phenomena and management of these two diseases and their vectors. ILRAD collaborates with several NARS in Africa and is actively involved in the "Nairobi cluster" of veterinary and animal diseases research.

ITA's mandate focuses on the development of crop and resource management in the humid and semi-humid tropical countries of sub-Saharan Africa. In addition, it is involved in crop improvement programs in cassava, yams, grain legumes (cowpea), soybeans, and maize. Improved high-yielding and disease-resistant varieties of cassava, and grain legumes have been developed, and maize hybrids and high-yielding open-pollinated maize varieties with resistance to the streak virus have been developed and widely distributed in tropical Africa. Some significant contributions to the biological control of cassava mealybug in the cassava belt of Africa are among the major breakthroughs that have benefitted NARS. ITA operates a number of networks for cassava, maize, grain legumes, and production systems, and have been of assistance to NARS in grain legume improvement programs, e.g., Botswana and Mozambique, through collaborative national and regional programs.

WARDA, as a rice development association, has major responsibility for research and development in rice in West Africa. Its mode of operation involves strategic and applied research at its headquarters in Bouake and collaborative adaptive research and genetic evaluation with at least 13 NARS in the sub-region. Significant contributions are being made in both upland and irrigated rice and in rice production systems research. WARDA has significant and effective participation by West African agricultural research leaders in its governance.

ISNAR's mandate is specifically to assist the NARS of the developing countries in strengthening their agricultural research capabilities. Its major approach of assisting systems through diagnosis, planning, and implementation phases highlights its concern for institution and capacity building. It has been involved in at least 10 anglophone countries in sub-Saharan Africa. Such involvements have paid special attention to structural and organizational issues, human resources development, planning and programming, linkages, and development of physical and financial resources. The independent and objective analysis of systems has been of direct assistance to NARS. Systems see ISNAR as a partner in the process of capability development and institution building.

ICRISAT has two large components of its semi-arid systems in Africa (Niger and Zimbabwe). There are more semi-arid areas in many more countries in Africa than any other continent. ICRISAT crop improvement and development programs in sorghum, pearl millet, pigeon pea, chick peas, and groundnut have generated many improved cultivars, and collaborative programs in Zimbabwe, Kenya, Malawi, Niger, and Nigeria have capitalized on both crops programs and vertisols and environment management technologies developed in ICRISAT's programs.

Other IARCs, with headquarters elsewhere, have many viable regional and national programs in which they are collaborating with African NARS. CIAT has several programs on beans in Rwanda, Tanzania, Uganda, Ethiopia, etc. CIP is involved in white potato and sweet potato improvement and storage in many countries of Africa. CIMMYT maintains a regional program in eastern and southern Africa with a focus on maize, wheat, and triticale improvement and farming systems. IBPGR has an active program of assisting many countries in genetic resource conservation and utilization, and IKRI collaborates with WARC and many other NARS in improving the rice production and management potential of Africa.

In addition to the CGIAR centers, other centers, such as ICRAF (agro-forestry), ICIPE (pest management), Winrock, and various United Nations agencies provide assistance in their areas of competence.

All these IARCs have paid particular attention to human resources development through research/production training, postdoctoral training, special training in research techniques, senior- and middle-level management training, and training in station development and management.

The impact of IARCs in strengthening structure and organization of NARS has been considerable, at both organization and program levels.

15. The Future

The challenges for the future for NARS in sub-Saharan Africa are many and varied. The major challenges, however, are to cope with the population growth and pressure on the natural resources of the region, to develop relevant, improved technologies for sustainable agriculture, and most importantly, to bring about a "green revolution" on the African continent. In these challenges, NARS have important roles to play, and they must be strong and able to demonstrate improved organization and management for greater effectiveness and efficiency.

Several issues will receive major focus through organized NARS research. These will include:

- the development and utilization of improved varieties of cassava;
- the development and utilization of improved varieties of upland and irrigated rice;
- the development of marginal lands for increased productivity;
- soil and water management, including the development of irrigation technologies;
- pest and disease management in both crops and livestock;
- improvement of wildlife management and productivity;
- improved cultivars of sorghum and millet;
- the expansion and development of improved maize varieties, beyond the successes already achieved in Zimbabwe, Kenya, Zambia, Malawi, and latterly in Nigeria and Ghana;

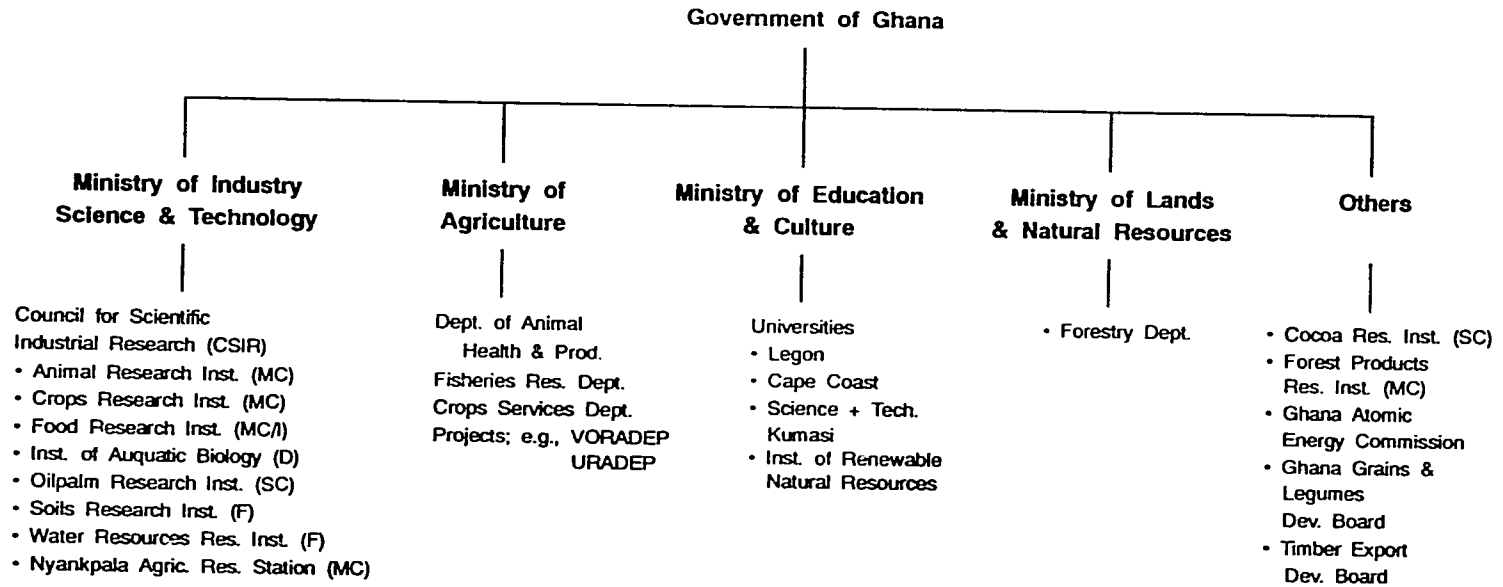
- the development of systematic mechanisms for priority setting and responsive program formulation;
- the strengthening of the models of structure and organization that show promise of effective contribution to the development process;
- the development and strengthening of linkages to technology transfer systems;
- the development of the involvement of universities in national agricultural research so as to fully utilize available scarce resources;
- the strengthening of links with IARCs and other technology and knowledge systems;
- the increased and meaningful involvement of the private sector in research and in supporting research.

The overriding consideration will be in examining organization and structures that are functional now, to create stability and continuity in these, and investigate ways of continually improving them to address these future challenges.

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Figure 1: Structure and organization of agricultural research in Ghana



Notes: MC= Multi-Commodity, SC= Single-Commodity, F= Factor, D= Discipline, I= Industrial. CSIR is a semiautonomous council.

Figure 2. Structure and Organization of the Kenya Agricultural Research Institute 1988

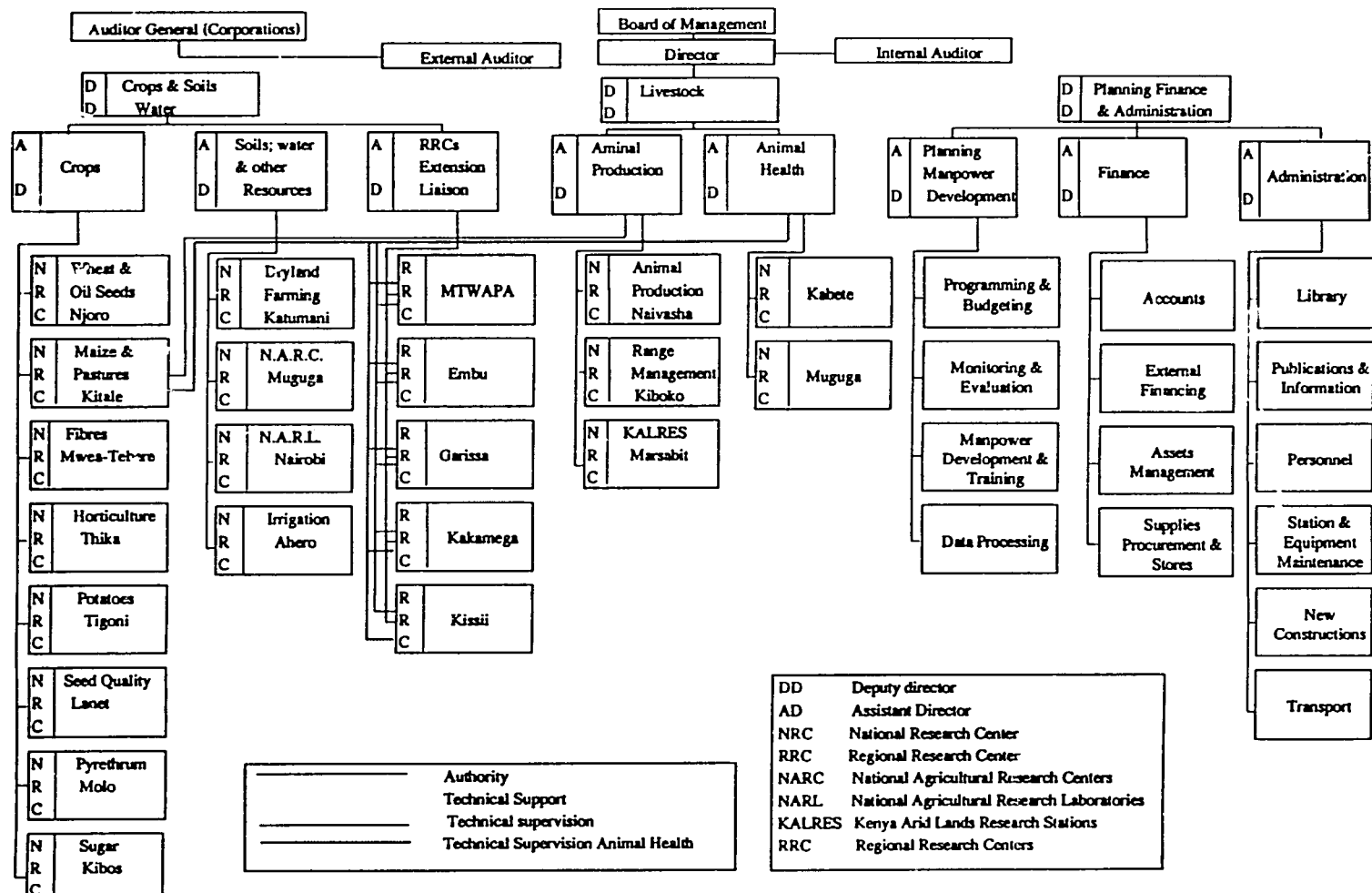
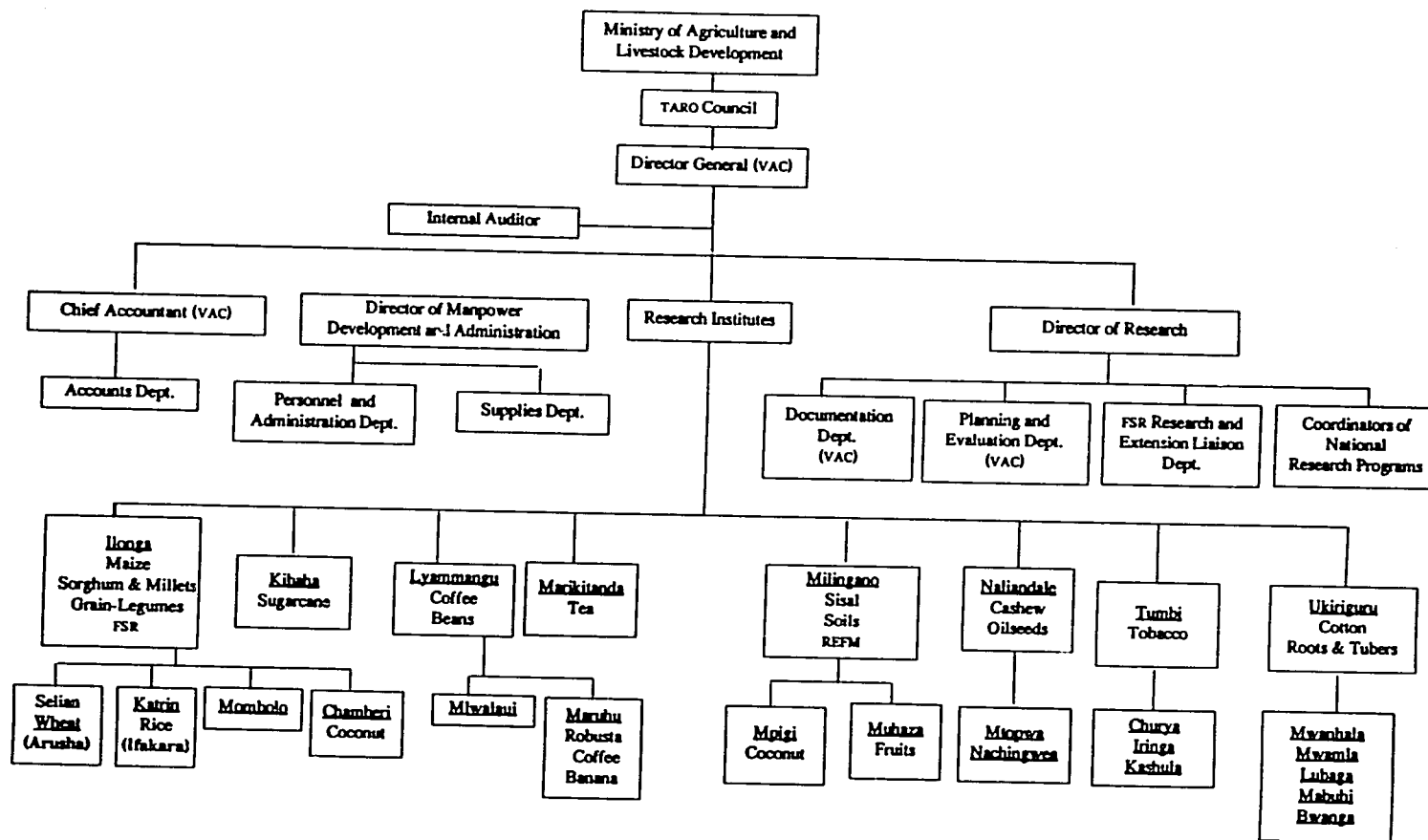
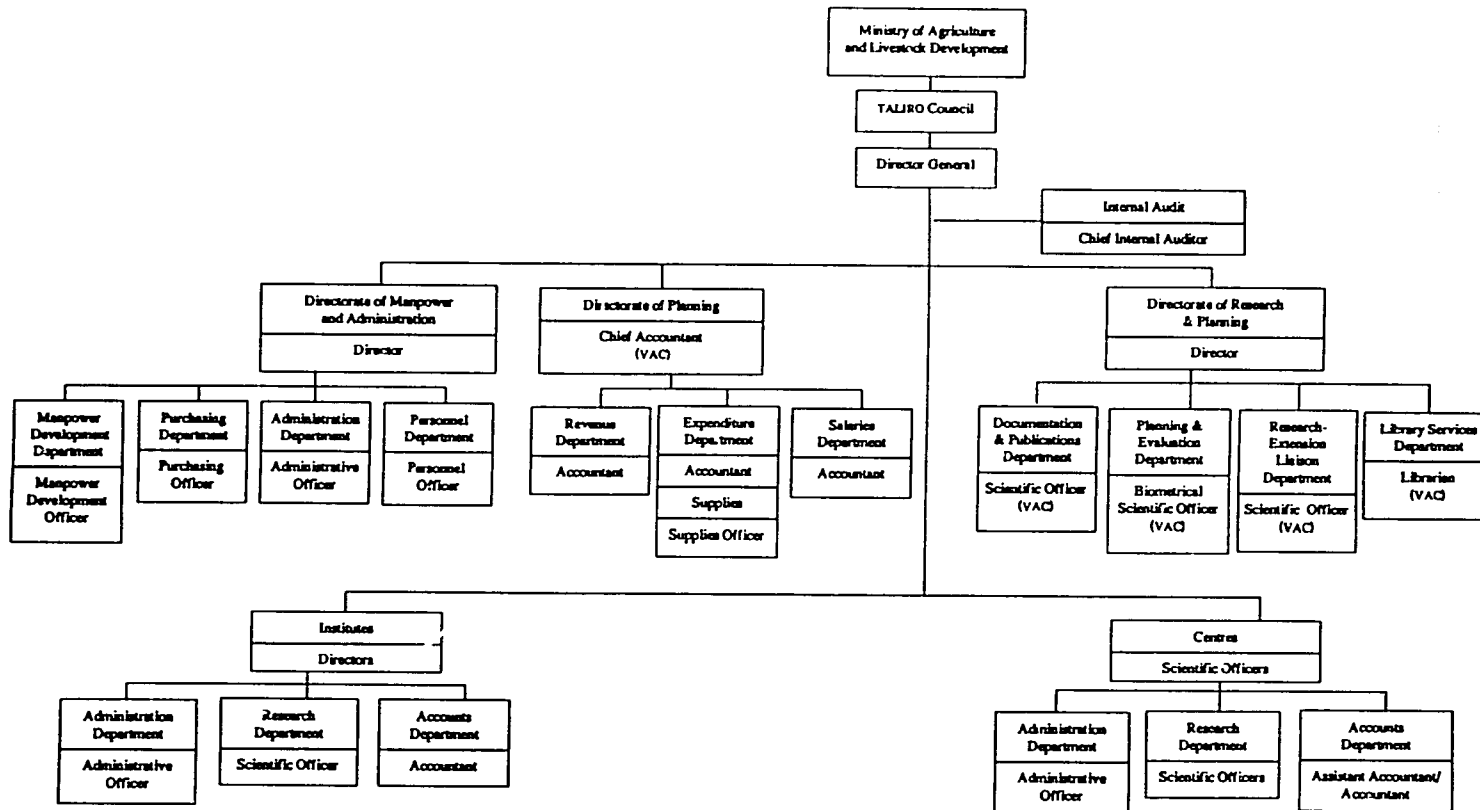


Figure 3: Structure & Organization of the Tanzania Agricultural Research Organization (TARO) 1988/89



NOTES: (1) (VAC) signifies that the post of head of the unit concerned is vacant.
(2) REFM resource of efficient farming methods (includes organic farming).

Figure 4: Structure and Organization of Tanzania Livestock Research Organization (TALIRO) 1988/89



- Notes: 1. (VAC) Signifies that the pst of head of the unit concerned is vacant.
2. Heads of departments are currently senior or principal officer rank.

Figure 5: Structure and Organization of Agricultural Research in Tanzania, 1988/89

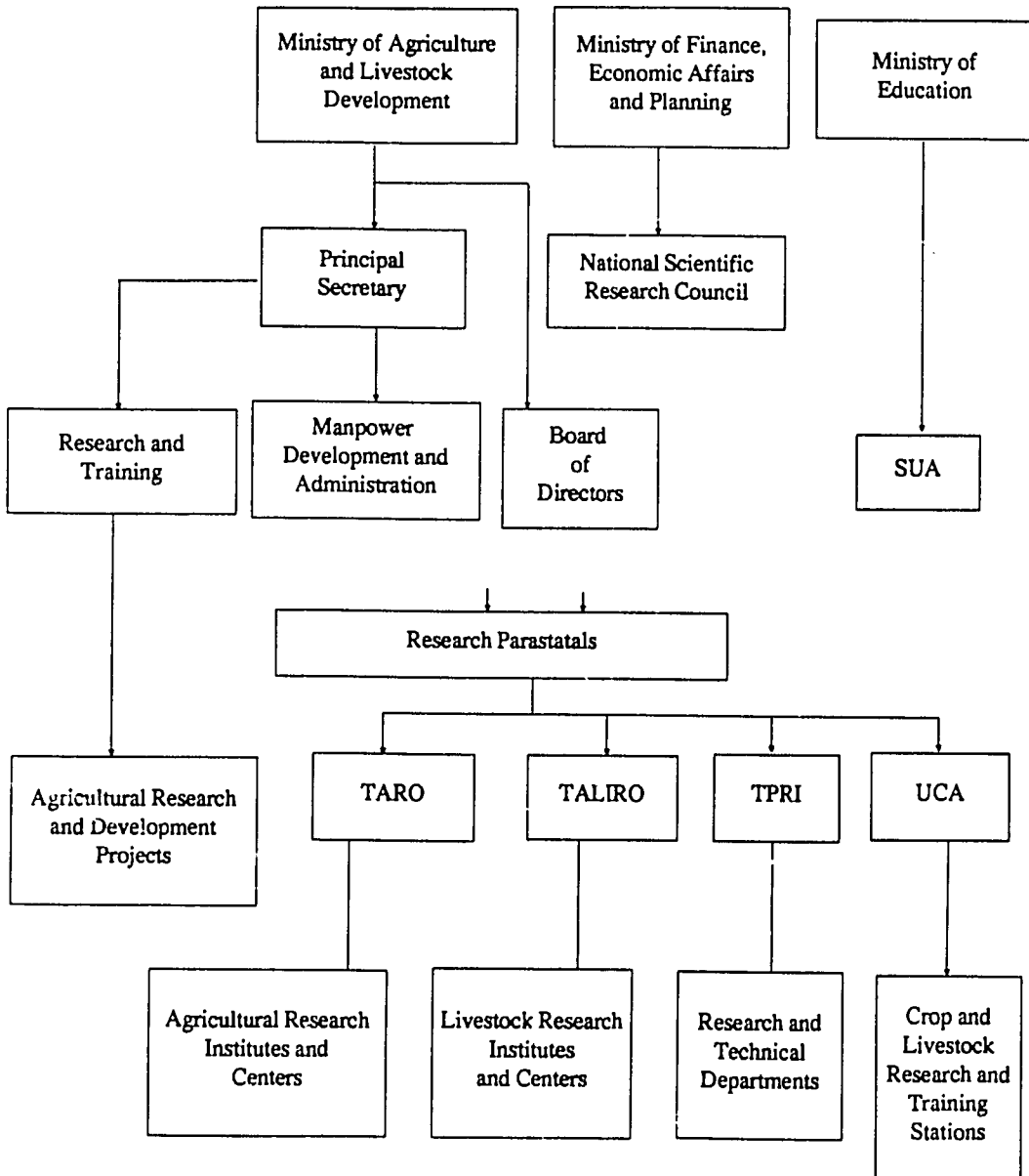
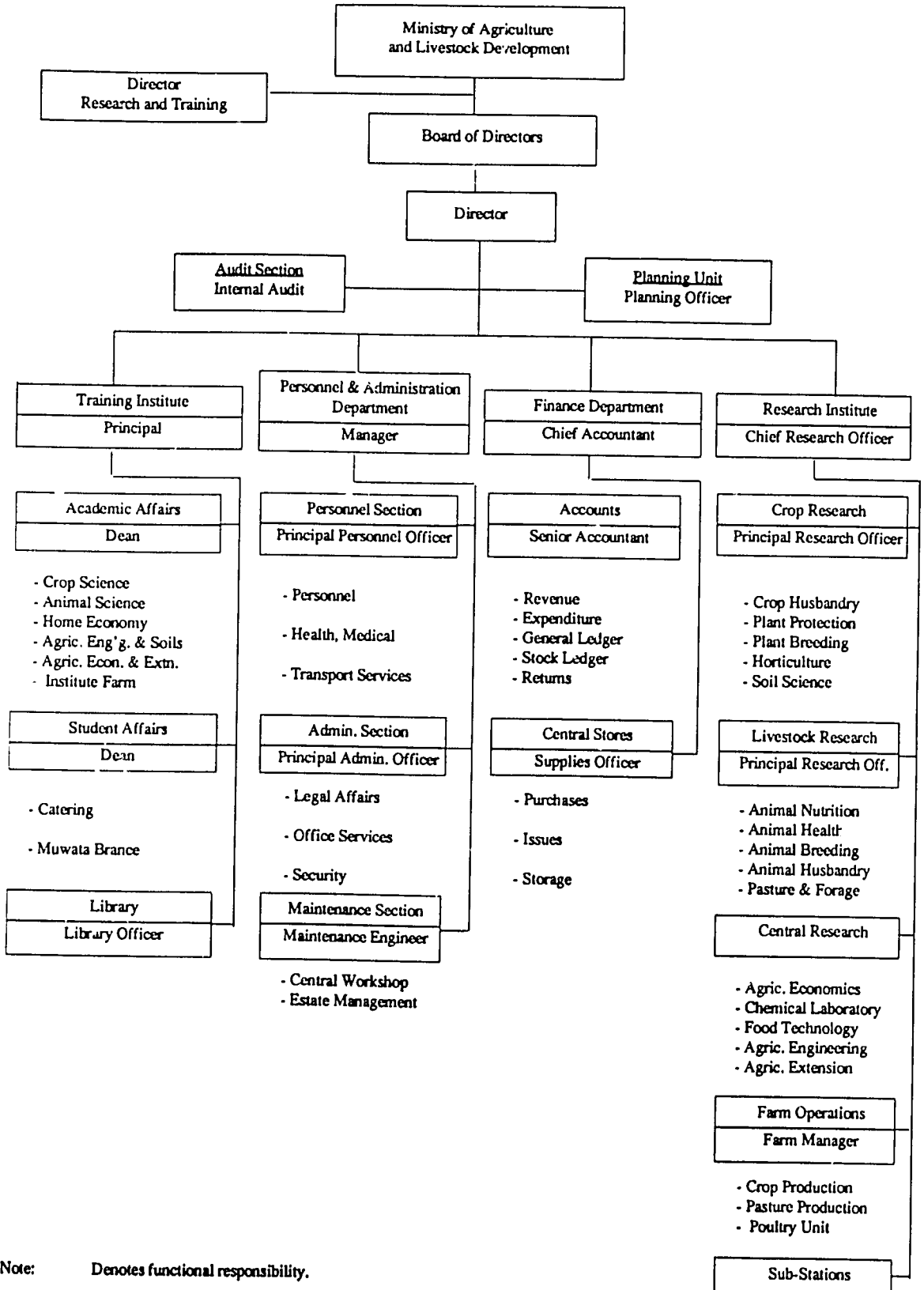


Figure 7: Structure & Organization of Uyoile Agricultural Center (UAC) in Tanzania (Regional Research Center)



Note: Denotes functional responsibility.

Figure 8: Structure & Organization of the Tropical Pesticides Research Institute (TPRI), Tanzania
(Factor Research Institute)

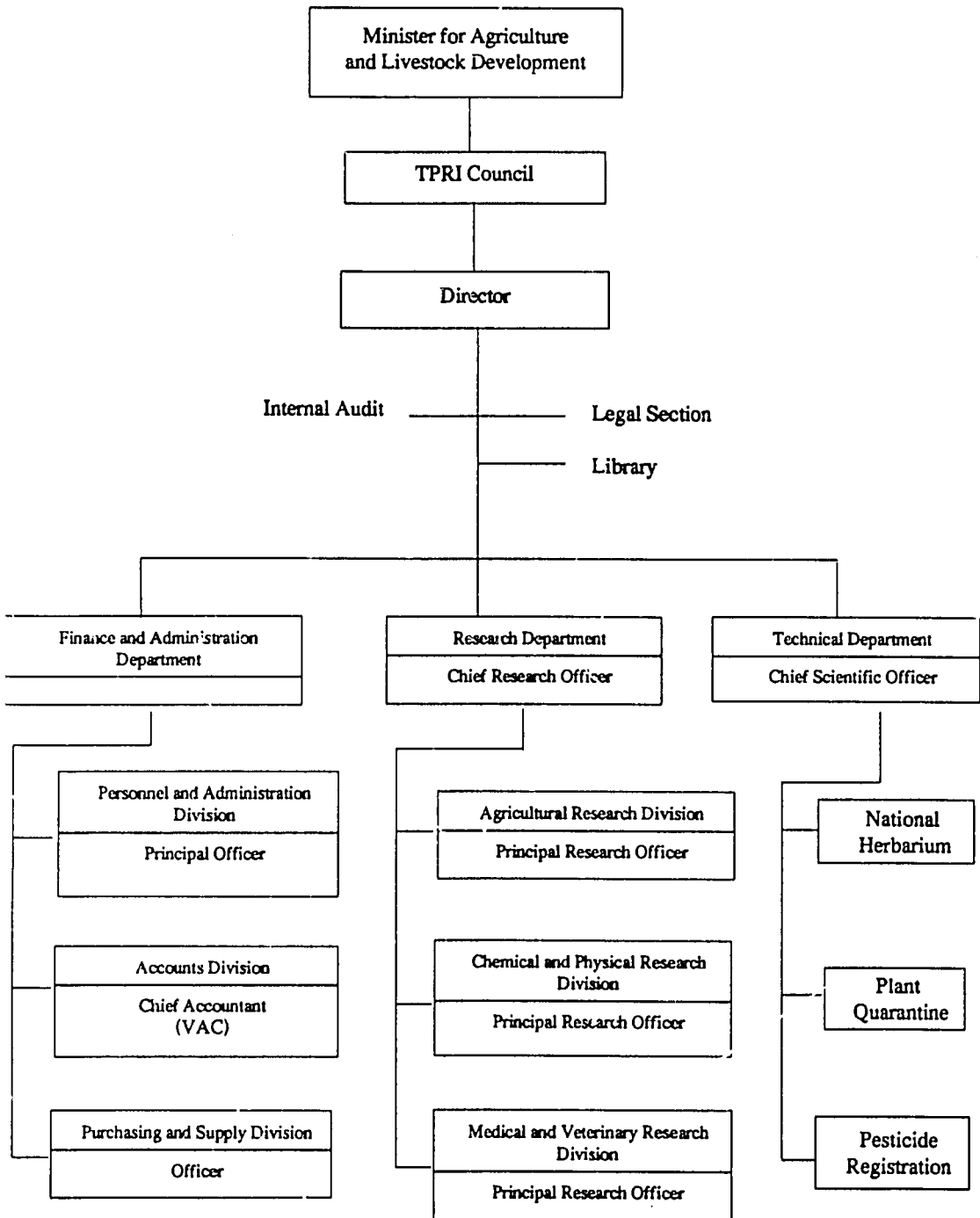


Figure 9: Current Structure and Organization of the Department of Agricultural Research Botswana

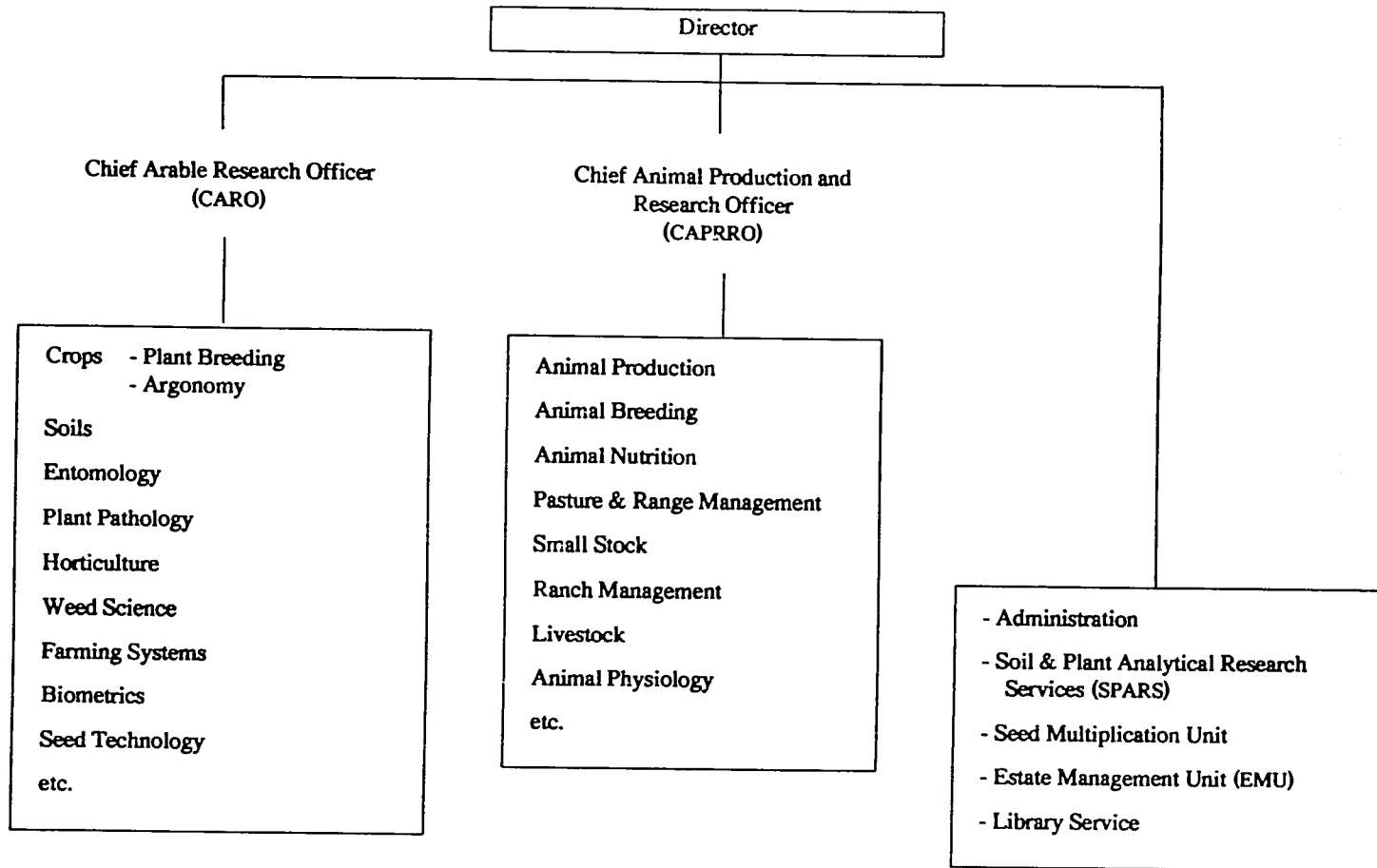


Figure 10: NARS structure and functions in relation to planning, formulation, and implementation of research, and dissemination of results and conclusions.

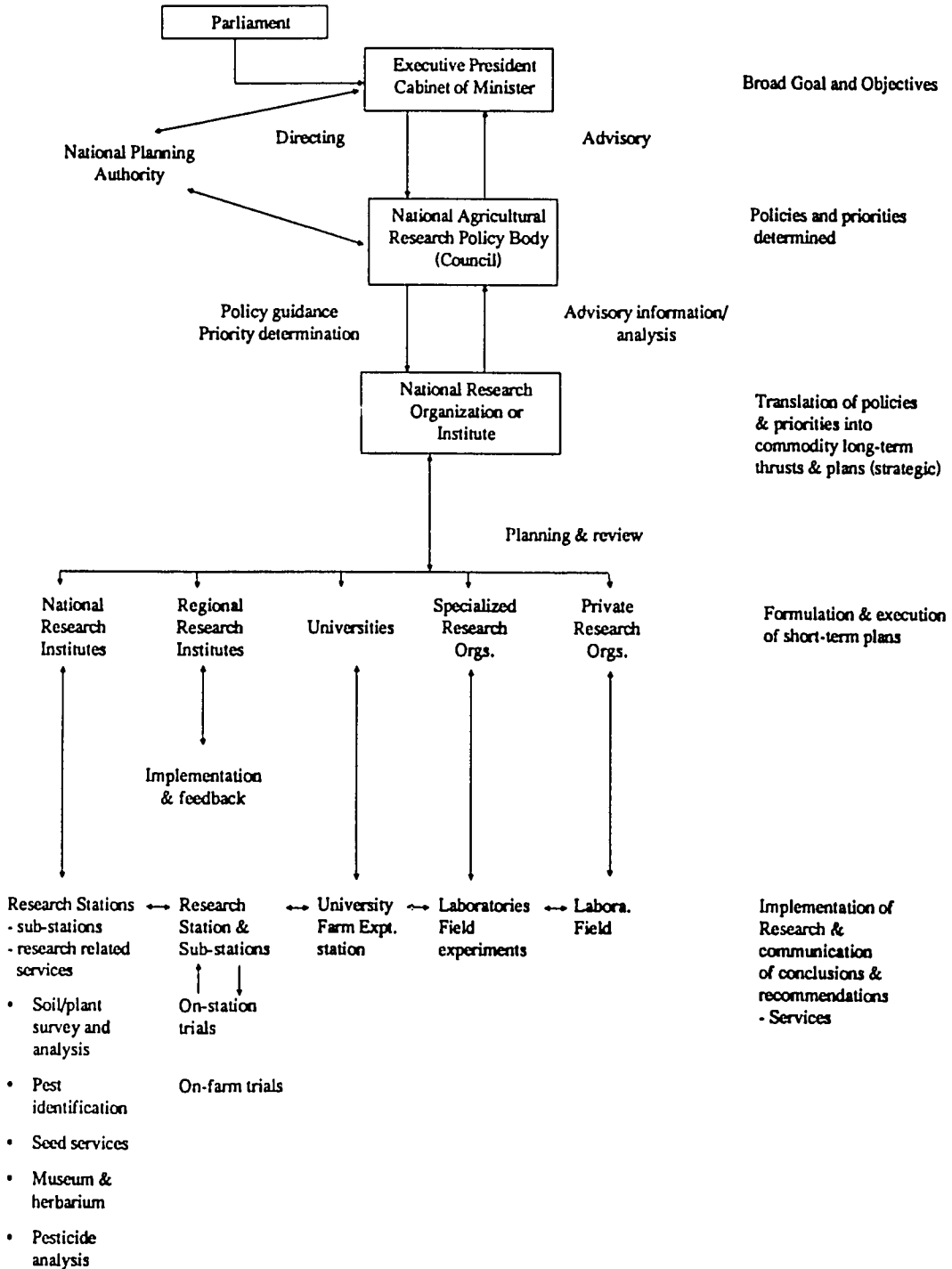


Figure 11: Structure of the Department of Agriculture in Zambia's Ministry of Agriculture

